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Issue 4

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USSR Space Life Sciences Digest

Issue 4

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*Management and Technical Services Company
Washington, D.C.*

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CONTENTS

Reader Feedback Form	v
FROM THE EDITORS	vi
ADAPTATION	1
BIOCHEMISTRY*.....	4
BIOLOGICAL RHYTHMS	4
BIOSPHERICS	5
BODY FLUIDS	13
BOTANY.....	15
CARDIOVASCULAR AND RESPIRATORY SYSTEMS.....	26
CYTOLOGY	37
DEVELOPMENTAL BIOLOGY	40
ENDOCRINOLOGY	44
ENZYMOLOGY*	45
EXO BIOLOGY	45
GENETICS*	50
GRAVITATIONAL BIOLOGY*	50
HABITABILITY AND ENVIRONMENT EFFECTS	50
HEALTH AND MEDICAL TREATMENT	52
HEMATOLOGY	54
HISTOLOGY	62
HUMAN PERFORMANCE	65
IMMUNOLOGY	66
LIFE SUPPORT SYSTEMS*	67

* Topics marked with * have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

MATHEMATICAL MODELING	67
METABOLISM	70
MICROBIOLOGY	72
MUSCULOSKELETAL SYSTEM	74
NEUROPHYSIOLOGY	78
NUTRITION	90
PERCEPTION	91
PERSONNEL SELECTION	93
RADIOBIOLOGY	94
CURRENT TRANSLATED SOVIET LIFE SCIENCE MATERIALS AVAILABLE TO OUR READERS	107

* Topics marked with * have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

To our readers: We are working in a large number of highly technical, specialized areas for which adequate Russian-English glossaries have yet to be compiled. We ask your help in improving the accuracy and specificity of our English terminology. Please fill out the form below whenever you encounter an incomprehensible, incongruous, awkward or otherwise inappropriate term. While we solicit all suggestions for improved renderings, the statement that a term is inappropriate provides us with useful information, even when no better alternative can be suggested. A copy of this form will appear in all future issues of the Digest. Thank you for your help.

Abstract #	!Incorrect or contextually inappropriate word or phrase:	!Suggested rendering: ("??" is an acceptable entry)
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PLEASE RETURN TO: Dr. Lydia Hooke
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FROM THE EDITORS

This is the fourth issue of the USSR Space Life Sciences Digest. This issue introduces a new format, which we have adopted as a result of a reader's suggestion. Abstracts are no longer grouped primarily according to type of publication -- periodical article, monograph or book review -- but are now grouped according to topic. In this way a reader may locate all those abstracts relevant to a particular field in the same section. Within each section, paper abstracts will be first, followed by monograph abstracts and translated book reviews. We will continue to cross-reference abstracts relevant to multiple topic categories.

Because of reader interest in the monograph "Biological investigations on "Salyut" orbital stations" (see abstract included in Issue 1 of this Digest, pp. 66-69) and our failure to identify a generally available translation, we have included abstracts of nine papers published in this monograph in the current Digest issue. These papers appeared of particular interest in light of the relative scarcity of journal papers relevant to NASA's Botany, Microbiology, Exobiology, Radiobiology, and Developmental Biology and Embryology research programs, as well as of reports of flight experiments. We intend to include additional abstracts of papers from this book in future issues of the Digest and will consider summarizing especially relevant chapters or papers from other monographs we have abstracted when these are identified by our readers.

We are currently preparing an index of the first four issues of the Digest, which we plan to publish as a separate NASA report.

In this issue we have reached the page limit for NASA publications of this sort. Any further attempt to expand the length and level of detail of our abstracts would have to result in a decrease in the number of abstracts per issue and vice versa. We welcome reader feedback on this matter.

It may be useful for readers who have occasion to deal with untranslated Soviet tabular material to know that the Soviets reverse standard American use of the comma and period when writing numbers. Thus, 1,000,000 is written "1.000.000" and 1.34 is written "1,34."

ADAPTATION
(SEE ALSO BIOSPHERICS: M43; HEMATOLOGY: P150)

PAPER

P145(12/85) Kolenda YuV, Vovchuk SV, Levitskiy AR. Effect of kallikrein on the development of the general adaptive syndrome. Patologicheskaya Fiziologiya i Eksperimental'naya Terapiya. 1985(4):52-54. [14 references; None in English] Affiliation: City Hospital No. 2, Odessa.

Adaptation, General, Stress

Rats

Countermeasures; Enzymology, Kallikrein; Immobilization

Abstract: Three experiments were performed, using a total of 125 male Wistar rats aged 2-3 months. In the first experiment 17 rats were immobilized on their backs for 8 hours; 18 other rats were injected subcutaneously with a dose of 2.5 mg/kg kallikrein and then immobilized; a third group served as a control. After immobilization the animals were sacrificed and physiological stress assessed on the basis of concentrations of various kinds of leukocytes, number of ulcers in the mucous membrane of the stomach, weight of the adrenal and thymus glands and concentration of corticosteroids in the blood. In the second experiment, length of survival from the start of immobilization for rats injected every 12 hours with a dose of 2.5 mg/kg of kallikrein was compared to length of survival of immobilized rats not given kallikrein. In the third experiment, changes in the concentration of aldosterone was measured in the blood of rats after injections of 2.5 mg/kg and 5 mg/kg kallikrein.

In the first experiment, immobilization produced the classical symptoms of the adaptation syndrome: leukocytosis, aneosinophilia, lymphopenia, stomach ulcers, hypertrophy of the adrenal glands, involuted thymus, and increased concentration of corticosteroids in the blood. Injection with kallikrein almost completely normalized these stress indicators. Kallikrein also increased the survival of immobilized rats from a mean of 17.0 hours to a mean of 30.0 hours. The third experiment showed that injection of kallikrein increased the level of aldosterone in peripheral blood to an extent proportional to dose. The authors concluded that the adaptation facilitating effect of kallikrein is mediated by the adrenal cortex and results in decreased production of glucocorticoids and increased synthesis of mineralocorticoids.

Table Titles: Table 1: The effect of kallikrein on the development of the adaptation syndrome in rats subjected to immobilization stress

Table 2: Change in the concentration of aldosterone in peripheral blood plasma of rats under kallikrein administration

BOOK REVIEW

BR6(12/85) Mityushov MI, Pushkarev YuPm Shalyapina VG. Review of Khaydarkiu SKh. *Funtsional'naya biokhimiya adaptatsii*. Kishinev: Stiintsa; 1984. 270 pp. In: *Fiziologicheskiy Zhurnal SSSR imeni I.M. Sechenovva*. LXXI(9): 1180-1181; 1985.

Biochemical changes occurring in neuronal structures of the peripheral and central nervous systems play an important role in the initiation and development of stress reactions and the functional disturbances these induce. The cause of these changes may be primary afferent signals occurring in response to stressors, as well as various hormones, especially corticosteroids. A substantial portion of this monograph is devoted to clarifying how these factors affect neural formation.

In his analysis of the relationships between individual reactions and stress, the author emphasizes short-term or emergency adaptation. Referring both to results of his own experimental work and data cited in the literature, the author discusses in detail the metabolism of various classes of compounds and the general mechanisms underlying metabolic regulation during short-term adaptation to altered environmental conditions. Particular emphasis is given to mediated adaptation, i.e., the use of various measures to enhance the body's capacity to adapt.

The author elucidates the role of cholinergic, catecholamine and amino acids and, finally, peptidergic systems in adaptation. The first two systems are described in the greatest detail. It is noted that cholinergic formations participate in short-term adaptive reactions from the very beginning of exposure to extreme factors, possibly serving as the leading and controlling pathway for transmitting and integrating neural impulses, and, thus, participate in the formation of the specific and general components of adaptation. It is hypothesized that drugs that activate the cholinergic system directly affect homeostasis.

Equal attention is given to description of the kinetics of the catecholamines in the tissues and blood in response to stress. On the basis of consideration of the numerous and highly contradictory results, the author proposes the following three-phase model of the "turnover" of catecholamines in response to certain types of stress.

1) Activation, occurring in response to norepinephrine liberated from the hypothalamus and other components of the nervous system, and accompanied by increasing secretion of catecholamines by the adrenal gland affecting cardiac function; 2) Stable activation, accompanied by increased secretion of catecholamines into the blood, decreased levels of catecholamines in the adrenal glands, lowered concentration of glycogen and accelerated formation of glucose in the kidneys, falling levels of epinephrine in the hypothalamus and other cerebral areas; 3) Exhaustion, decreased activity of the hormonal and peripheral mediators; lowered concentration of epinephrine in the adrenal gland, blood and heart, and lowered concentration of its precursors; increase in the permeability of the blood-brain barrier to

epinephrine.

The book emphasizes that the direction and ionic mechanism of synaptic (mediated) or hormonal effects is determined by the molecular structures at the postsynaptic target -- cellular receptors. A modern treatment is given to discussion of the links between hemoreceptor cells and intracellular metabolic process. The mechanism of glucocortical hormones proceeds according to a somewhat different model: interaction of the hormone at the level of cellular cytoplasm, translocation of the hormone receptor in the cell nucleus and de nova synthesis of adaptive enzymes.

In considering the role of various chemical compounds in specific and general adaptive mechanisms, a good deal of emphasis is laid upon the unique -- and physiologically crucial-- functions (catabolic, anabolic, energy producing, transport, protective) of proteins in adaptive reorganizations at the organismic level in response to the environmental factors. A discussion of the participation of nucleic acids in adaptive processes is provided. As a rule, no change in DNA is found in short-term adaptation to the effects of environmental stimuli.

In his discussion of the levels (cell, tissues, organ, organism) at which adaptive reactions are regulated, the author devotes considerable attention to the sympathetic adrenergic and hypothalamus-pituitary-corticoadrenal systems. However, insufficient attention is given to explaining intersystem and, especially, intermediator relationships, under both normal and extreme conditions.

This book will certainly be of interest to physiologists and biochemists with a wide variety of specialties and also to practitioners in the areas of medicine, sports and animal husbandry.

BIOCHEMISTRY: SEE ADAPTATION BR6

BIOLOGICAL RHYTHMS

(SEE ALSO BIOSPHERICS: M53; METABOLISM: P143)

MONOGRAPH

M49(12/85) Alyakrinskii BS, Stepanova SI; [Volume editor: O.G. Gazenko]. Po zakony ritma [Following rhythm's law]. Moscow: Nauka; 1985. [176 pages].

Affiliation: Institute of Biomedical Problems

Key Words: Biorhythms: Human Performance, Job Performance, Cosmonauts, Cosmonaut Schedules

Annotation: This book discusses the significance of biological or natural rhythms and various aspects of human life and job performance, including the professional duties of the cosmonaut. In a readily accessible form, extensively illustrating the technical points with examples from the literature, the authors lead the reader along the freshly discovered paths of this new scientific area. While doing this, they make reference to data from the Soviet and foreign scientific literature relevant to the fundamental concepts of the study of biorhythms. This book is intended for the [general] reader interested in problems of physiology, medicine and also biomedical support of space flight.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Nature and rhythm (6)

Rhythmic processes in living creatures (17)

The circadian system of the body. Timers. (59)

Desynchronosis (90)

The problem of "days" in space (110)

Basic principles for structuring and scheduling the lives of human beings in space (159)

Conclusion (171)

Recommended reading (173)

BIOSPHERICS

PAPER

P147(12/85) Vinogradov BV. Aerospace methods in ecological prediction. Priroda. 1985(7): 13-23. [11 references; 3 in English]
 Affiliation: A.N. Severtsov Institute of Evolutionary Animal Morphology and Ecology, USSR Academy of Sciences.

Biospherics
 Review Article
 Ecological Prediction

Abstract: Use of remote sensing data, particularly comparison of photographs of the same areas at different times, is ideally suited to monitoring and predicting anthropogenic changes in the Earth's ecology. If prediction is to be accurate, careful selection of the time interval between the photographs being compared is essential. For regions where ecosystems are generally stable and anthropogenic effects are minimal, an interval of 10-15 years is sufficient; however, the number of such regions is steadily decreasing. Regions where less than 0.5% of the area of the major ecosystems changes during a 1-year period would require an interval of 7-10 years. The majority of forest and agricultural regions fall into this category. In regions where approximately 2% of the area changes in a year, an interval of 3-5 years between space photographs is appropriate. In rapidly changing environments photographs should be taken once a year or even more frequently. Scale is another important parameter of remote sensing photography. As with time interval, the optimal value depends on the type (simple vs. complex) and stability of the ecosystems being monitored. The author states that the scale of the photograph should facilitate a reliability factor of 95-99% in feature identification. Remote sensing photographs may be read (decoded) visually or using optical, photographic or computerized instruments. The author describes a frequently used computerized method which first classifies the representations being compared and then eliminates features replicating those in earlier photographs. The goal of this enterprise is to identify an ecological trend and thus enable ecological prediction.

The author cites several regression equations that describe relationships between particular ecosystem components and time. Parameters for these equations were derived from comparison of photographs taken at different times. These parameters include: rate of change in amount of land occupied by a particular component; an exponent indicating the linearity or nonlinearity of the rate of change; and hypothetical year when the change began. When such equations are extrapolated to predict future states of the ecosystem, they can be used to avert undesirable or even catastrophic situations, e.g., desertification. For example, remote sensing data indicate that the a desert-salt marsh ecosystem will cover the whole Amudar desert by 2024 if measures are not taken to increase water supply; meadow moors will have disappeared by 2015 and certain characteristic plantlife by 1994. If space photographs taken in subsequent years reveal improvement or deterioration of conditions, predictions can be revised and alterations made in planned corrective measures.

In complex ecosystems with multiple ecological components, a vector is constructed to represent the land area characterized by each component in a photograph. Vectors derived from photographs of the same area at two different times are then compared and a matrix is constructed representing a statistical model of the ecological dynamics of the region and encompassing all the changes which have occurred in the interval between photographs. The most thorough Soviet analysis of this type was performed for a complex forest-swamp-meadow region in Central Latvia using a series of photographs taken in 1936, 1956 and 1974 and data collected on the ground in 1983. Only 20% of the area where changes were noted was undergoing natural shifts in ecosystems, while 80% of the changes were anthropogenic. Analysis of the model showed that the entire region could be subdivided into two subsystems: forest-swamp and forest-meadow. Over the 18-year period between photographs, 99% of the shifts occurred within subsystem and fewer than 1% of the shifts involved inter-subsystem shifts. On the basis of extrapolation of the changes noted, quantitative predictions were made about the course of the ecosystem over the next 18 year period.

Remote sensing data can also be used to draw conclusions about the geophysical effects of ecosystem changes. For example, it has been estimated that a moderate amount of overgrazing of currently unused pastures would increase the average yearly luminance factor by 0.04, moderate clearing of forests would increase this factor by 0.08, while burning of savanna would decrease the luminance factor of a given region by 0.08. These geophysical changes would have important climatic consequences. It has been demonstrated that a change in reflectivity of 0.01 would alter the average yearly temperature by 2.3° . While anthropogenic changes may appear to have only minimal effects on overall geophysical parameters averaged over the course of a year, these effects may have significant ecological impact during certain seasons. For example, at one point in the growing season, cultivation of steppe land was estimated to increase the luminance factor by 0.18.

Figure Titles: Graph 1. Changes in area suitable for cultivation (I) and cultivated land in several areas of the Rostov region.

Graph 2. Change in the area of lake beds and reed vegetation (curve I) and area of salt marsh water meadows (curve II) in the Amudar delta.

Graph 3. Exponential growth of the area of loose sands in the chernozem in Western Prikaspiya.

Graph 4. Influence of land use on the optical characteristics of the Earth's surface.

Article also illustrated with many photographs.

MONOGRAPHS

M52(12/85) Krasnogorskaya NV, Fokin AV, Laskorin BN, editors.
Electromagnitnyye polya v biosfere. Tom I: Electromagnitnyye polya v atmosfere zemli i ikh biologicheskoye znachenie [Electromagnetic fields in the biosphere. Volume I: Electromagnetic fields in the atmosphere of Earth and their biological significance]. Moscow: Nauka; 1984. [27 tables; 85 figures; 919 references]

Affiliation: Scientific Council on Biospheric Problems, USSR Academy of Sciences; All-Union Scientific Medical Technology Society, USSR Ministry of Health

Key Words: Biospherics, Electromagnetic Fields, Solar Activity, Anthropogenic Effects; Cardiovascular System, Modeling

Annotation: This book examines certain aspects of solar biospheric connections. Emphasis is placed upon formation of natural and anthropogenic magnetic fields, and their potential effects on physical, chemical and biological processes. Results of investigations of biologically-generated electromagnetic fields are cited and interpreted. Experimental data concerning human reactions to heliomagnetic activity and the possibility of predicting the effects of these fields on living systems and the human body are discussed. Methods for measuring, processing and analyzing experimental data in the area of electromagnetic biology are described, and certain practical applications of the biological effects of external fields to geophysics are discussed. This book is intended for specialists in a wide range of fields interested in the interaction between the environment and biological systems and in biospheric conservation.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Introduction (5)

Chapter 1. Electromagnetic fields of the atmosphere and their sources (15)

1. Geophysical electromagnetic fields (15)
 - 1.1 The sun as a source of electromagnetic and corpuscular radiation. Vladimirskiy VM (15)
 - 1.2 Solar activity and circulation processes in the troposphere. Ugareova KF, Pavlova NL, Kalantadze RSh (25)
 - 1.3 Variations in cosmic rays in the biosphere. Miroshnichenko LI(33)
 - 1.4 Geomagnetic fields and their variations. Ben'kova NP, Shevnin AD (40)
 - 1.5 Electrical fields in Earth's atmosphere and their source. Krasnogorskaya NV, Pokhmel'nykh LA(54)
 - 1.6 Electromagnetic fields of the Earth's atmosphere in the infrared range. Krasnogorskaya NV, Solov'yev SP (66)
 - 1.7 Atmospherics and their source. Makhotkin LG (72)

2. Anthropogenic electromagnetic fields (84)
 - 2.1 Bioeffects of exposure to anthropogenic electromagnetic fields. Venikov VA (84)
 - 2.2 Electrical fields created by super voltage electrical installations. Stolyarov MD (90)
 - 2.3 Electromagnetic fields in the vicinity of radar stations. Itskov VYa (101)
 - 2.4 Electromagnetic fields generated by motion in a geomagnetic field. Trukhanov KA, Shevnin AD (109)
3. Biological electromagnetic fields and radiation (118)
 - 3.1 The electrical fields of biological objects. Gulyayev PI, Zabotin VI, Shlippenbakh NYa. (125)
 - 3.2 External infralow frequency electromagnetic fields generated by organisms. Tornuyev YuV, Kudel'kin SA (133)

Chapter 2. The effects of heliogeophysical factors on the biosphere and humans (141)

1. Human reactions to solar activity (141)
 - 1.1 Possible geophysical mechanisms through which solar activity affects an organism. Vladimirskiy BM (141)
 - 1.2 The significance of the sector structure of the interplanetary magnetic field on synchronization of psychophysical regulation in humans. Rudakov YaYa, Mansurov SM, Mansyrova LG, et al. (150)
 - 1.3 The effect of heliogeophysical factors on cardiovascular and pulmonary pathology. Bogutskii BV, Pyatkin VP (159)
 - 1.4 Predicting the frequency of complications in cardiovascular disease. Zaslavskaya RM, Livshits IG, Lerner NV (166)
 - 1.5 The possibility of predicting prevalence of myocardial infarction from the analysis of geophysical data. Kondratyuk IK, Boborykin AM, Yemel'yanov (177)
 - 1.6 On long-term prediction of epizootics. Lavrovskiy AA, Popov NV, Drobinskaya OK, et al. (184)
2. Reactions of modeled systems to solar activity (193)
 - 2.1 The effect of solar activity on oxidation rate of thiol compounds. Sokolovskiy VV (193)
 - 2.2 Analysis of a series of observations with a monothiolic test. NI Muzalevskaya, Sokolovskiy VV (201)
 - 2.3 Comparison of readings obtained from monothiolic and acrylonitrile tests with spontaneous changes in the enzymatic activity of nerve tissue. Pavlova RN, Zaytseva NK (215)
 - 2.4 Correlation of macroscopic fluctuations in biological and chemical processes with physical space factors. Agulova LP, Udal'tsova NV, Shnol' SE (220)
 - 2.5 Chromatic reaction of tryptophan. Moskalyanova YeN, Saley AP [page number missing in original]
 - 2.6 The effect of heliomagnetic fields on bacterial agglutination. Opalinskaya AM, Agulova LP (228)
 - 2.7 On the role of water in the primary mechanisms through which heliogeophysical factors effect the simplest models of living systems. Kislovskiy LD (240)

Chapter 3. Problems of measurement and utilization of natural electromagnetic fields (246)

1. Methods for measuring electric and magnetic fields (246)
 - 1.1 Methods for measuring electrical fields in the atmosphere. Krasnogorskaya NV, Mel'nikov VA, Rybin VV, Solv'yev SP (246)
 - 1.2 Methods for measuring a geomagnetic field and its variations. Finger DL (257)
 - 1.3 Methods for measuring electromagnetic fields generated by living organisms. YuV Tornuyev (270)
 - 1.4 Quantum gradometer for measuring magnetic fields generated by biological subjects. Kozlov AN, Sinel'nikova SYe, Fomin IO (279)
 - 1.5 Liquid crystal displays of electrical and magnetic fields. Chistyakov IG, Vistin' LK, Radzhabova ZB, Chumakova SP (286)
2. Methods for processing and analyzing experimental data (294)
 - 2.1 Systems approach to solving problems involving interaction of biological subjects and the environment. Reymers ZB (294)
 - 2.2 Using computer methods for studying the effects of electromagnetic fields on biological systems. Chenyshev MK (300)
3. Practical applications of electromagnetic fields and the reactions of living systems to external influences (325)
 - 3.1 Alteration of the atmosphere's electric field as a possible precursor of earthquakes. Vorob'yev AA, Remizov VP (311)
 - 3.2 Use of living systems to predict earthquakes. Krasnogorskaya NV, Protasov VP, Kharybin YeV, et al (315)
 - 3.3 The role of the electromagnetic field in the study of the internal structure of the Earth and methods for interpreting electromagnetic anomalies. Zhdanov MS (325)

Chapter 4. Some theoretical aspects of the problem (331)

1. Vector potential of an electromagnetic field. Trukhanov KA (331)
2. Charge equivalent and its possible role in the generation of an electrical field by biological systems. Dokuchayev VI (350)
3. Designing experiments to detect extrasensory communication between biological subjects. Perov VP (362)

M53(12/85) Krasnogorskaya NV, Fokin AV, Kaznacheyev VD, editors. Electromagnitnyye polya v biosfere. Tom II: Biologicheskoye deystviye elektromagnitnykh poloy [Electromagnetic fields in the biosphere. Volume II: The biological effects of electromagnetic fields] Moscow: Nauka; 1984. [325 tables; 54 figures; 1062 references]

Affiliation: Scientific Council on Biospheric Problems, USSR Academy of Sciences; All-Union Scientific Medical Technology Society, USSR Ministry of Health

Key Words: Biospherics, Electromagnetic Fields, Adaptation, Metabolism, Enzymology, Biorhythms, Modeling, Health and Medical Treatment

Annotation: This book presents the results of research on the effects of electromagnetic fields spanning a broad range of frequencies on biological systems and models of such systems. It evaluates the role played by states of nonequilibrium in living matter, electrical forces and informational processes in these phenomena. General approaches are discussed, as are results of research on the mechanisms underlying the bioeffects of electromagnetic fields and radiation. Particular attention is devoted to the mechanisms governing the effects of weak signals and bioamplification[?]. The role of external factors in medicinal treatment is evaluated, and examples cited of practical utilization of the effects of electromagnetic fields in medicine and biology. This book is intended for specialists in various areas who are interested in interactions between the environment and biological systems, and in conservation of the biosphere. It will also be useful to ecologists, biophysicists, biochemists, medical personnel and others working in related areas.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Introduction (3)

Chapter I. The effect of electromagnetic fields on living systems (5)

1. General issues (5)

- 1.1 Permanent disequilibrium -- the basis for selective sensitivity on the part of the organism. BG Rezhbek.
- 1.2 Reactions of living systems to weak adequate stimulation. LD Kislovskiy (16)
- 1.3 The skin as a potential communication channel. AA Yaroshenko, LM Konovalova (26)

2. Reactions of living systems to electromagnetic fields (46)

- 2.1 Change in adaptive reactions and resistance during exposure to electromagnetic fields. LKh Garkavi, EB Kvakina, et al.(46)
- 2.2 The effects of background electromagnetic radiation on the kinetics of normal and malignant growth. V.N. Yur'yev, NV Krasnogorskaya (56)
- 2.3 Physiologically active infralow frequency magnetic fields. VB Makeyev, NA Termur'yants, et al.(62)

- 2.4 Selective sensitivity of bacteria to infralow frequency magnetic fields. YuN Achkasova (72)
- 2.5 Human reactions to exposing skin to light with various spectral components. NN Lysenko (73)
- 2.6 Reactions of the central nervous system to low frequency electromagnetic fields. AM Volynskiy (77)
- 2.7 Human sensory reactions to magnetic fields. YuA Kholodov, YuV Berlin (83)
- 3. The effects of electromagnetic fields on blood (89)
 - 3.1 Changes in certain electrical properties of the blood induced by electromagnetic fields. NV Krasnogorskaya, AI Miroshnikov, et al. (89)
 - 3.2 The effect of electromagnetic fields on the blood coagulation system. VF Rusyayev (97)
- 4. The effects of electromagnetic fields on metabolism and enzyme activity in vivo. (108)
 - 4.1 The effects of electromagnetic fields on metabolism and metabolic regulation. NA Udintsev (108)
 - 4.2 The effects of electromagnetic fields of various frequency ranges on metabolism and enzymatic systems. FA Kolodub (115)
 - 4.3 Alteration of the enzymatic activity of leukocytes during exposure to electromagnetic fields. CB Petrichuk, ZN Dukhova, et al. (124)
 - 4.4 The effects of magnetic fields on enzyme systems. SA Pavlovich (128)
- 5. The effects of certain environmental factors on the generation of biorhythms (145)
 - 5.1 The effect of electromagnetic fields on biological rhythms. VB Chernyshev, VM Afonina, et al. (145)
 - 5.2 Seven-day cycles in cardiovascular complications and their correlation with variations in the geomagnetic field. RM Arslanova, VI Pochtarev, NG Ptitsina (150)
 - 5.3 Changes in rhythms of motor activity in the period immediately preceding death in the loach. YuV Marshukov (156)
 - 5.4 Lunar influence on biorhythms, MM Gorshkov, NA Agadzhanyan (165)

Chapter II. Mechanisms underlying the effects of electromagnetic fields on biological and modeled systems (171)

- 1. Possible mechanisms underlying the effects of magnetic fields on living systems (171)
 - 1.1 General characteristics of research on the mechanisms underlying the bioeffects of electromagnetic fields. LA Shelepin, NV Krasnogorskaya, et al. (171)
 - 1.2 The possible source of electrodynamic phenomena in living systems. YeZ Gak, NV Krasnogorskaya (179)
 - 1.3 The possible role of asymmetry of biological structures in regulatory effects. VYe Zhvirblis (185)
 - 1.4 On the mechanisms responsible for the bioeffects of low frequency electromagnetic fields. VM Abashin, GI Yevtushenko (193)
 - 1.5 On the physical and chemical mechanisms responsible for the bioeffects of microwaves. ESh Ismaylov (201)

2. Investigation of the effects of electromagnetic fields on models of living systems (207)
 - 2.1 The principles governing the effects of magnetic fields on the rate of nonequilibrium processes. YeL Frankevich (207)
 - 2.2 Molecular mechanisms responsible for the effects of a magnetic field on radical reactions in solutions. TV Leshina, RZ Sagdeyev (216)
 - 2.3 The possible role of electrical nonequilibrium states in the mechanism of bioamplification. NV Krasnogorskaya, VN Yur'yev (223)
 - 2.4 The effect of a nonhomogeneous electric field on cellular suspensions. VM Fomchenkov, BK Gavril'yuk, et al. (232)
 - 2.5 The possible mechanisms responsible for alteration of the functional status of an isolated heart under exposure to a magnetic field. AN Kudrin, NF Zhdanova (242)
 - 2.6 The role of calcium and phosphorous ions in the realization of magnetobiological effects. VB Makeyev, NA Temur'yants (247)

Chapter 3. Practical applications of electromagnetic fields in medicine and biology (249)

1. The effects of external factors on the organism and their role in medicinal treatment. NV Krasnogorskaya, et al. (249)
2. Some biochemical problems in magnetobiology and magnetotherapy. VM Aristarkhov (256)
3. Utilization of electromagnetic fields in diagnosis and therapy. VP Malov and MN Zakharova (261)
4. Methods for measuring electrical parameters of cells and their use in biology and medicine. NV Krasnogorskaya, et al. (271)
5. Electrical properties of cells as an indicator of pathology. MV Golovanov (284)
6. Rate of erythrocyte sedimentation in an infralow frequency magnetic field as a test for vascular pathology. NI Muzalevskaya (287)
7. The effects of low frequency magnetic fields on bone regeneration. IM Mitbreyt, VL Manyakhin. (287)
8. Magnetotherapy in ophthalmology. AA Verzin, AYe Selimonov, et al. (297)

Appendices

1. A global experiment on the "sun-climate-man" problem. VP Kasnachev, NR Deryapa (303)
2. Methodology for developing an MIS system in electromagnetic biology and medicine. AA Shpakov (312)

Conclusion (321)

BODY FLUIDS

PAPER

P156(12/85)* Noskov VB, Kozyrevskaya GI, Morukov BV, Artamasova YeM, Rustam'yan LA. Body position during hypokinesia and its effects on fluid-electrolyte exchange. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 31-34. [11 references; 6 in English] Affiliation: Not available

Body Fluids, Fluid-electrolyte Exchange
Humans, Males
Hypokinesia, Horizontal, Head-down Tilt

Abstract: Two groups of healthy men (five in each group) were subjected to 7 days of bedrest. Members of Group 1 lay in a horizontal position, while the beds of Group 2 were tilted head-down at an angle of -6° . For 2 weeks before the bedrest treatment, during it and during the recovery period, all subjects consumed the same standard diet amounting to 2500 to 2800 calories a day. Intake of water was not limited but was strictly monitored. All urine was collected. Intake and excretion of fluid, sodium, potassium, calcium and magnesium was determined. Since subjects differed in body weights, the values of all measurements were computed relative to body weight. When amount of fluid intake, as well as fluid excretion, was taken into account, it was found that members of both groups exhibited fluid loss during the first day of hypokinesia. This loss was significantly greater for the group subjected to head-down tilt. Some individuals decreased fluid intake, while diuresis was unchanged; while in others intake was less curtailed but diuresis increased substantially. All subjects in both groups showed increased excretion of sodium and accelerated glomerular filtration rate, as indicated by creatinine excretion. This occurred almost immediately after the beginning of bedrest for Group 2, but only on the second or third day for Group 1. Effects of the treatment on chlorine excretion for both groups was analogous to sodium excretion. Excretion of potassium and calcium was more pronounced in the second group. There were no significant treatment effects on magnesium excretion. By considering intake as well as excretion of electrolytes, it was possible to compute the balance of each electrolyte for each group. Sodium balance was negative for both groups, with the negative balance showing a tendency to be higher for Group 2. After the hypokinesia period, both groups tended to retain fluid and sodium. Bedrest led to weight loss for both groups, but this effect was more pronounced in Group 2.

Table and Figure Titles: Table: Daily excretion of substances under study at different periods by subjects in Groups 1 and 2.

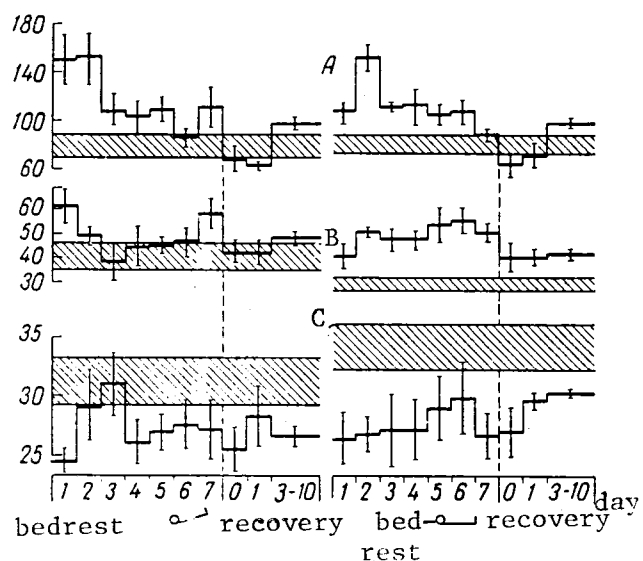


Figure 1: Daily renal excretion of sodium (A) and fluid (B) in relation to consumption (in %,) and fluid intake (C, in ml/kg) during bedrest and recovery [Here and in Figure 2, the crossed hatched bands represent the baseline level, in the 99% confidence interval.

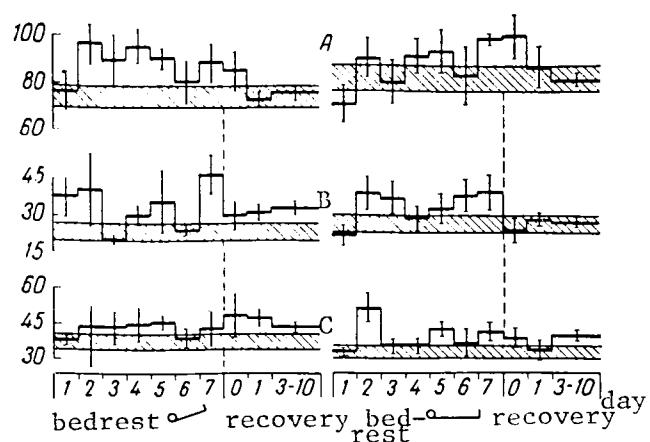


Figure 2: Daily renal excretion of potassium (A), calcium (B), and magnesium (C) in relation to consumption (in %) during bedrest and in the recovery period

Figure 3: Mean change per kg body weight for each group as a function of time

BOTANY
(SEE ALSO RADIOBIOLOGY: P184)

PAPER

P178(12/85) Laurinavichyus RS, Yaroshus AV, Radzyavichus G. A methodology for setting up experiments on the significance of gravity in plant growth and development processes. In Dubinin NP, editor, *Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut"* [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 15-20. (See Issue 1 of Digest, pp. 66-69.)

Botany, Growth and Development
Experimental Methods and Equipment
Space Flight, Salyut

Abstract: One of the major issues involved in designing botanical experiments in space is the selection of control conditions. The most generally used design utilizes a single terrestrial control which is compared to the entire set of space flight factors, with such parameters as temperature, illumination, water, and minerals provided strictly standardized for the two conditions. If investigation of the effects of a single space flight factor is the goal, then either the other factors must be simulated in the terrestrial control condition or the absence of the factor under study must be simulated in space as an additional control. Since it is impractical to simulate prolonged weightlessness on Earth, centrifugation is used to produce artificial gravity of 1-g in space for the purpose of experimental control. Alternatively, effects of prolonged weightlessness on plants can be simulated on Earth using a horizontal clinostat to distribute the gravitational force vector evenly around the long axis of the plant. If certain additional conditions are taken into consideration, then some of the effects of weightlessness can be simulated on Earth, as has been demonstrated by comparing results of space flight and clinostatic conditions on plants. If the horizontal clinostat itself is rotated in the plane perpendicular to the axis of the clinostat, a particular gravity level can be simulated. To perform this function, a device which combines the function of the clinostat and the centrifuge was developed to investigate the threshold sensitivity of various plant responses to gravity.

The experiments performed with higher plants on space flight vehicles can be divided into three groups: 1) experiments with air-dried seeds; 2) short-term experiments with sprouts in darkness; 3) longer term experiments on plants in light. The goals of the first class of experiments included the determination of radioactive sensitivity of plants and the effects of the complex of space flight factors on germination and other physiological indicators. A large number of genetic experiments were also performed on air-dried seeds. These experiments controlled for thermal conditions and radiation background. However, variability and lack of replicability of the results of these experiments may have resulted from failure to control for other factors. The second class of experiments was designed to study the course of the initial phases of development and spatial orientation of sprouts under space flight conditions. These

experiments are distinguished by their short duration and by the fact that the sprouts were grown in darkness. A special device was constructed for experiments of this type using pea and lettuce sprouts on board the "Salyut-13". This device is a spherical seed holder, with a tubular grating for anchoring the seeds, which can be filled with liquid nutrient. An additional variant of this apparatus included a ventilator for changing the atmosphere surrounding the germinating seeds.

The development of the "Biogravistat-1" device made it possible to compare two conditions in botanical experiments: 1) presence of all space flight conditions including zero or low gravity; 2) presence of all other space flight conditions, but with centrifugation creating artificial gravity of 1-g. This device has two compartments. The lower one contains a motor with a drive and electronic control circuit. The upper one contains a centrifuge rotor and a stationary cultivation block. Detachable seed holders are attached to the centrifuge rotor.

Another device, the "Oasis-1M" system was developed to aid in investigating the role of light as a substitute for gravity in directing the orientation of plant growth. This system contains cultivation blocks with a nutrient substratum under fluorescent lights.

The "Fiton-2" device was developed for the study of seed-to-seed development of plants under sterile conditions. This device consists of a container with transparent walls fitted with mountings for five removable beakers containing an agar nutrient mixture. An automatic seed sowing device is mounted on the side wall and ventilation is accomplished by pressing a membrane which forces air through a filter. Fluorescent lights are used with the device. The "Biocontainer" device is often used with the "Fiton-2" to provide reliable and rapid fixation of biological materials without requiring the operator to be in contact with the chemical fixatives. Plans are being made to outfit the "Fiton-2" with a centrifuge.

Figure Titles: Figure 6. Centrifuge-clinostat

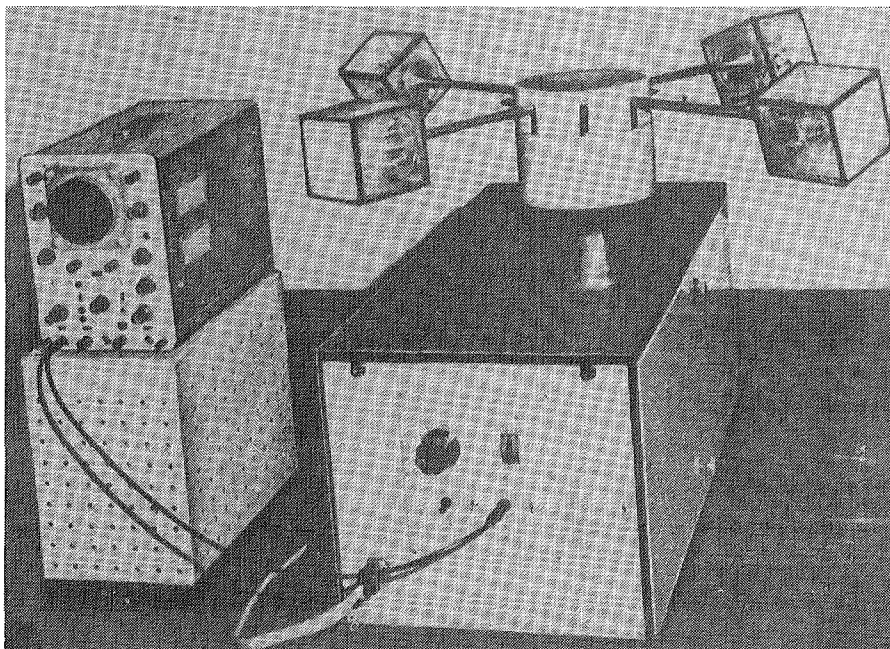


Figure 7. Container for cultivating plants under altered gravity conditions: a) reservoir with nutrient liquid, b) feeder tube, c) seed holder with sprouts

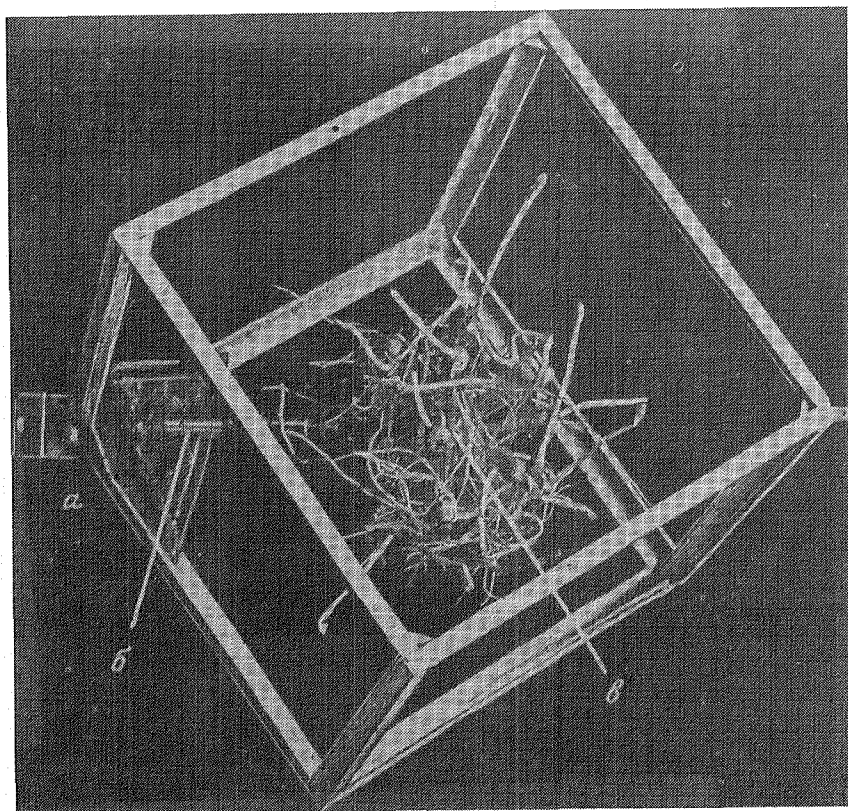


Figure 8. The "Biogravistat-1" and "Biocontainer" devices

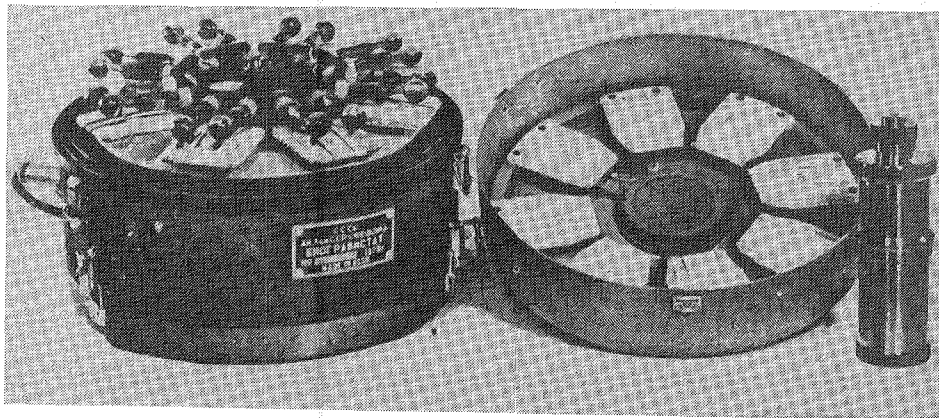
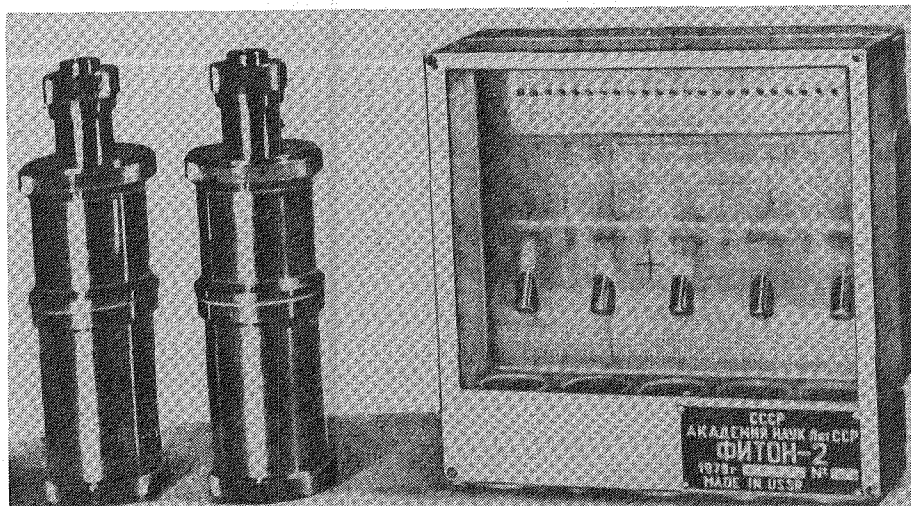


Figure 9. The "Fiton-2" and "Biocontainer" devices



P179(12/85) Merkis AI, Laurinavichyus RS, Shvyazhdene DV. Spatial orientation and growth of plants under weightlessness and in an artificial gravity field. In Dubinin NP, editor, Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 72-81. (See Issue 1 of Digest, pp. 66-69.)

Botany, Orientation and Growth

Lettuce and Cress

Space Flight, Salyut; Weightlessness; Artificial Gravity

Abstract: The experiments described in this paper used centrifugation during space flight in order to examine the role of gravity in the spatial organization, morphogenesis and growth of differentiated structures in germs of seeds of lettuce (Lactuca sativum L.), pepper cress (Lepidium sativum L.) and mouse-ear cress (Arabidopsis thaliana Heynh) plants. Artificial gravity was created for these experiments using the "Biogravistat-1" apparatus described in abstract number P178 of this issue. In each experiment, there were two conditions in space (weightlessness, and artificial gravity of 1-g) and two on Earth (normal plant growth conditions and centrifugation along a horizontal axis, with gravitational pull fluctuating between 0 and 2-g.). Four experiments were performed on the "Salyut-6" using the plants listed above and lasting from 96 to 120 days. In all experiments centrifugation ceased during the night for 8-9 hours. In space the air-dried seeds were moistened with distilled water before the experiment began and fixed after it terminated and before return to Earth. Temperature ranged between 19-22°. In the first experiment, where seeds under centrifugation were oriented so that their growth axis corresponded to the artificial gravity axis, growth of the hypocotyl and root was linear and normal, corresponding to the anatomical determination in the germ. This was not the case with the seeds germinated under weightlessness (see Figure 28). When seeds were randomly oriented, direction of growth in weightlessness was determined by orientation, while under centrifugation direction was determined by direction of the predominant force vector (see Figure 29). These experiments are interpreted as confirming the ability of centrifugation to replace gravity as a determinant of early plant growth in space. Results were confirmed by cytological data. Under both weightlessness and horizontal clinostasis on Earth, both amyloplasts of the cell cap and cell nuclei showed displacement compared to position under normal growth conditions. Cells in plants centrifugated in space showed no such displacements (see Figure 30).

Other experiments using "Biogravistat-1" investigated the quantitative effects of weightlessness on growth. Weightlessness had no adverse effect on the germination of lettuce or pepper cress seeds, confirming previous results with other plants (see Table 23). However, results differed with the mouse-ear cress; considerably fewer mouse-ear cress seeds germinated under weightlessness than on Earth or under centrifugation in space. Contrary to expectation, the length of the hypocotyl was greater in all three plants studied under weightlessness than it was under centrifugation in space. In space, root length was identical in two cases and greater under centrifugation in one (Table 24). However, for all three plants,

length of both hypocotyl and root was less under both space conditions than under both Earth conditions, suggesting the role of factors other than gravity.

In the experiments performed, effects of weightlessness were different than those of clinostasis on Earth, indicating that the utility of clinostasis as a simulation is limited. Results also indicated the importance of the differences in the sensitivity of different plants to space flight factors. Comparison of effects of experimental conditions on growth factors and on root cells suggest that cytological indicators can be used to study the functional significance of gravity for plant ontogeny.

Figures and Tables:

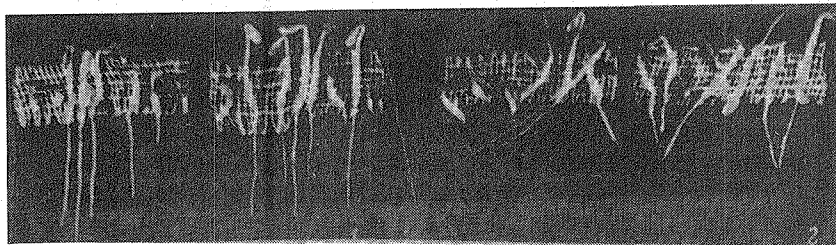


Figure 28. Spatial orientation of lettuce sprouts.
1 - sprouts germinated on centrifuge; 2 - sprouts germinated in weightlessness and vertically aligned

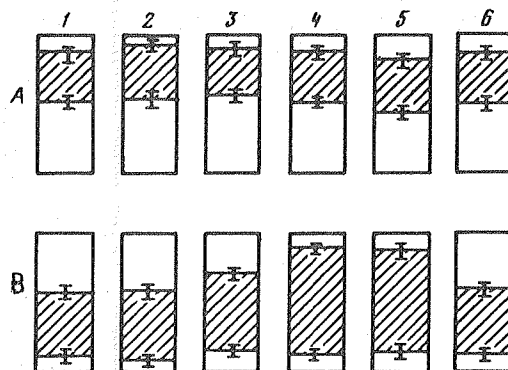


Figure 30. Position of nuclei (A) and amyloplasts (B) in root cap cells of lettuce
1 - Earth stationary control; 2 - Earth centrifuge control; 3 - space centrifuge; 4 - weightlessness; 5 - horizontal clinostasis; 6 - vertical clinostasis

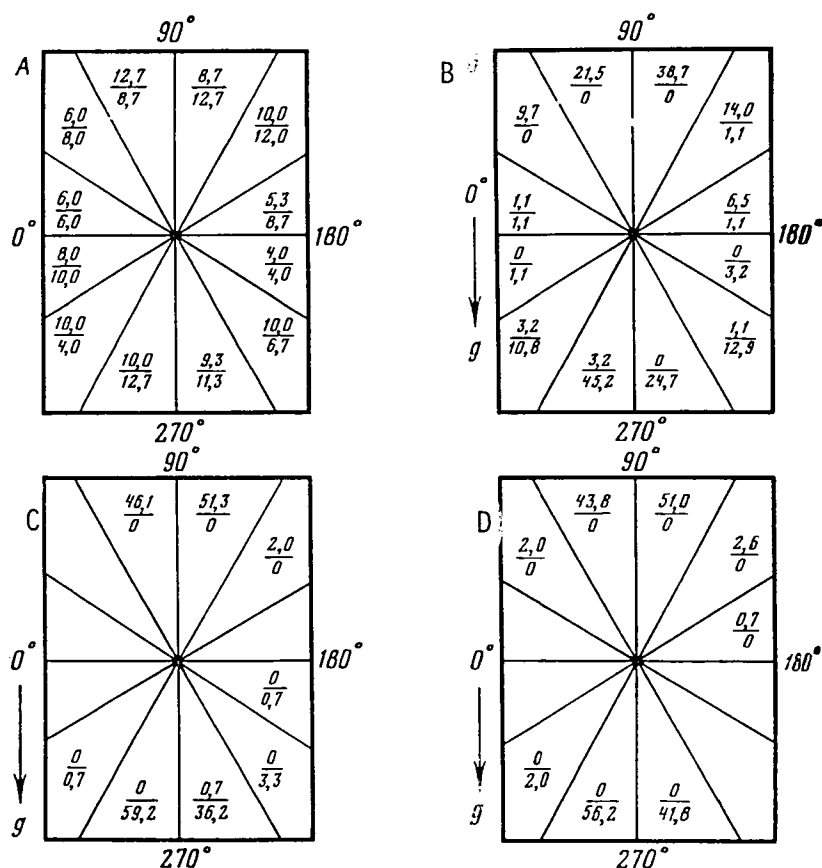


Figure 29. Orientation of lettuce hypocotyls and roots in a plane (hypocotyls/roots in %) as a function of the direction of force of the gravity vector or centrifugal force. A - weightlessness; B - centrifugation in space; C - stationary Earth control; D - centrifugation Earth control.

Table 22. Germination of seeds and growth of sprouts in the "Biogravistat-1" on Earth

Plant	Germination		Hypocotyl Length,		Root Length,	
	Percentage	Cent. Stat.	mm	mm	mm	mm
			Centrif.	Station.	Centrif.	Station.
Lettuce (I)	88.0	87.3	13.9	11.1*	19.2	16.8*
			N=88	N=69	N=87	N=70
Lettuce (II)	61.6	70.8	20.4	18.8*	28.3	28.9
			N=151	N=159	N=148	N=136
Pepper	86.0	89.0	26.1	24.6	35.9	37.7
Cress			N=70	N=51	N=70	N=48
Mouse-ear	60.5	57.5	3.20	3.36	1.74	1.39
Cress			N=58	N=63	N=57	N=60

* Difference statistically significant, $p < 0.05$.

Table 23. Effects of weightlessness on germination of seeds and growth of sprouts

Plant	Germinating Power		Hypocotyl Length ($\bar{x} \pm s_x$), mm		Root Length ($\bar{x} \pm s_x$), mm	
	Cent.	0-g	Centrif.	0-g	Centrif.	0-g
Lettuce (I)	88.2	88.3	5.08 N=78	6.34* N=72	9.51 N=76	9.43 N=73
Lettuce (II)	85.9	89.1	7.04 N=38	10.97** N=45	14.17 N=44	16.34 N=45
Lettuce(III)	61.6	68.0	5.88 N=112	10.64** N=184	10.06 N=109	17.28** N=154
Pepper Cress	84.2	85.0	20.5 N=101	22.2* N=99	28.3 N=98	33.0 N=94
Mouse-ear Cress	53.1	20.6***	1.35 N=85	2.30** N=33	0.99 N=83	0.97 N=30

Difference statistically significant,* $p < 0.05$; ** $p < 0.01$; *** not marked as significant in the table, but clearly so described in the text.

Table 24. Hypocotyl and root length of lettuce (mm) after 98 hours of rotation in a horizontal clinostat (2 rev./min)

Condition	Length	
	Hypocotyl	Root
Stationary control	20.62	29.37
Vertical clinostat	19.21	30.37
Horizontal clinostat	16.69*	25.22*

* Difference significant, $p < 0.01$.

P181(12/85) Laurinavichyus RS, Yaroshyus AV, Marchyukaytis A, Shvyagzhdene DV, Mashinskiy AL. Metabolism of pea plants grown under space flight conditions. In Dubinin NP, editor, Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 96-101. (See Issue 1 of Digest, pp. 66-69.)

Botany, Metabolism
Pea
Space Flight, Salyut

Abstract: This experiment investigated the hypothesis that space flight conditions affect not only the spatial orientation and anatomical and morphological structures of plants, but also the rate and direction of the physiological and biochemical reactions responsible for synthesis and transformation of cellular components. Specifically, it examined the effects of 24 days of exposure to space flight conditions on the molecular composition of pea plants. Pea plants were grown in the "Oasis-1" (see abstract P178) device on board the "Salyut-4." The living plants were returned to Earth with no discernible damage, fixed and analyzed. The quantity of pigment (chlorophyll a and b, lutein, and carotene), albuminous and nonalbuminous nitrogen, proteinogenic amino acids, nucleoproteins, hydrocarbons (total hexose and pentose, starch, cellulose, hemicellulose) and important mineral elements were determined using appropriate methods. As Table 26 shows, the content of chlorophyll a and b was significantly lower in plants exposed to weightlessness than in terrestrial controls, indicating either retarded biosynthesis or intensified breakdown of these pigments. Lutein content was also depressed, but carotene was 26.1% higher than in control plants. It is hypothesized that the latter effect may be due to inadvertent overheating of the plants in space. Table 27 shows that both albuminous and nonalbuminous nitrogen content was depressed as a result of exposure to space. Exposure to space also led to a 10-15% decrease in lysine, and tyrosine, while histadine, phenylalanine and ammonia increased by a similar amount. Analysis of the fractionation of complex cytoplasmic proteins and RNA showed only minor differences between plants grown in space and those grown on Earth. No major differences were found in the fractional composition of DNA. Although at the time biochemical analyses were performed little difference in growth rate had been noticed, analysis of hydrocarbons demonstrated significant differences between control and experimental plants. The experimental plants contained more alcohol soluble sugars and less starch than the control counterparts, indicating acceleration of hydrolytic processes. Space flight conditions led to pronounced changes in the quantity of cellulose; which was 54% lower than in the control plants. These changes indicated major alterations in the biosynthesis of plant cell components and may be interpreted as resulting from disruption of cellular metabolism. Space flight conditions also produced marked disruption in the equilibrium of the major mineral elements (Table 29): phosphorous content was elevated by a factor of 2.5; potassium by a factor of 1.5; concentrations of calcium, magnesium, manganese, zinc and iron, however, had decreased markedly. These changes are interpreted as demonstrating the disruption of selective uptake of ions, a process under the metabolic

control of root cells. The authors state that these results do not permit an unambiguous determination of the reasons for the disruption of plant metabolism under space flight conditions.

Figures and Tables: Figure 39. Ion-exchange chromatography of cytoplasmic proteins and RNA. A - control; B - experimental; 1 - 9 - protein fractions.

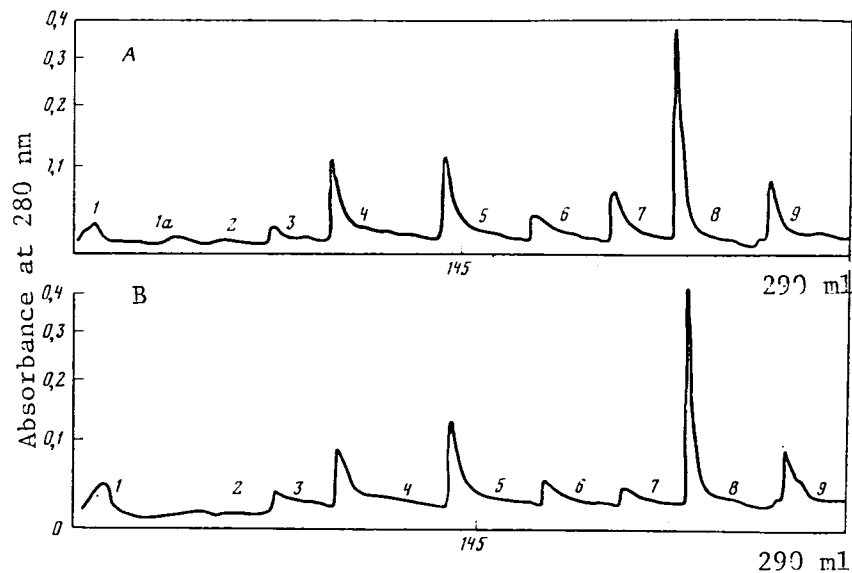


Figure 40. Gel filtration of DNA using Sephadex G-200. A - control; B - experimental

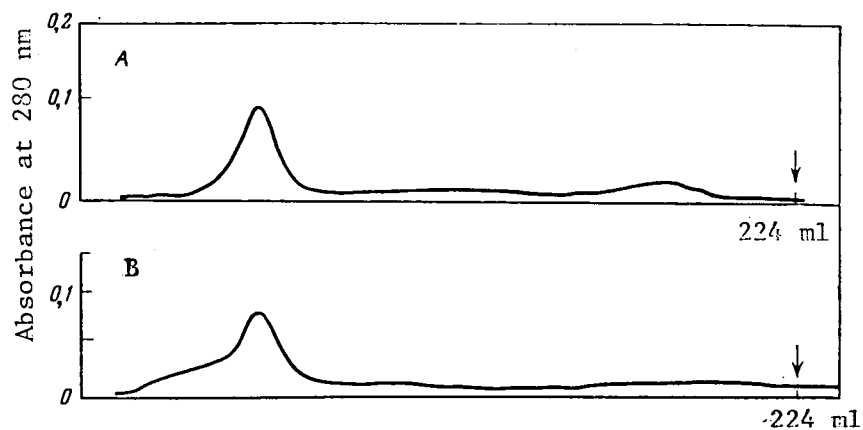


Table 26. The effects of space flight conditions on the concentration of pigments in pea leaves, mg % in dry weight

Pigment	Control	Experimental	% of Control
Chlorophyll a	231.33	146.67	63.4
Chlorophyll b	210.13	147.63	70.3
Lutein	10.10	7.37	73.0
Carotene	6.13	7.73	126.1

Table 27. Effects of space flight conditions on concentration of albuminous and nonalbuminous nitrogen in pea sprouts, % dry weight

Nitrogen Fraction	Control	Experimental	% of Control
Albuminous nitrogen	2.54	2.20	86.6
Nonalbuminous nitrogen	2.13	1.79	84.0
Total amount of nitrogen	4.67	3.99	85.44

Table 28. Effect of space flight factors on the concentration of proteinogenic amino acids and ammonia in pea sprouts, % of protein

Amino Acid	Control	Experimental	% of Control	Amino Acid	Control	Experimental	% of Control
Lysine	7.08	5.90	83.3	Proline	3.09	3.31	107.1
Histidine	1.70	1.90	111.7	Glycine	3.86	4.10	106.2
Arginine	4.47	4.35	97.3	Alanine	3.93	4.04	101.5
Aspartic acid	6.73	7.19	106.8	Valine	3.42	3.38	98.8
Threonine	3.48	3.45	99.1	Isoleucine	2.48	2.41	97.1
Serine	3.82	4.05	106.0	Tyrosine	0.87	0.78	89.6
Glutamic acid	8.32	8.09	97.2	Phenylalanine	3.61	4.12	114.1
Leucine	5.80	6.04	104.1	Ammonia	7.65	8.62	112.7

Table 29. The effects of space flight factors on the mineral components of pea plants (dry weight)

Condition	P, %	K, %	Ca, %	Mg, %	Zn, mg/kg	Mn, mg/kg	Fe, mg/kg
Control	0.62	3.36	1.79	0.46	156.2	311.5	158.5
Experimental	1.55	5.02	0.23	0.25	105.3	54.2	107.4
% of Control	250.0	149.4	12.8	54.3	67.4	17.4	67.7

CARDIOVASCULAR AND RESPIRATORY SYSTEMS
(SEE ALSO: BIOSPHERICS: M52; MATHEMATICAL MODELING M34; M41;
RADIOBIOLOGY: M37.)

PAPERS

P158(12/85)* Orlov VN, Fomin IO, Radzevich AE, Leskin GS. The effect of breathing pressurized air during immersion in water on hemodynamics in patients with borderline arterial hypertension. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 39-41. [14 references; 3 in English] Affiliation: Not available

Cardiovascular and Respiratory Systems, Hemodynamics
Humans, Patients, Hypertension
Hyperkinesia, Immersion; Pressure Breathing

Abstract: This study investigated the effects of positive pressure breathing on the hemodynamic parameters of individuals exhibiting borderline arterial hypertension who were undergoing a 7-day period of "dry" immersion. The 11 subjects, aged 45-51, underwent two 30-minute sessions of positive pressure breathing daily during the first 3 days of the immersion treatment. Positive pressure, equal to 10 cm Hg in the lungs, was created with a pressurized helmet and a compressor. The following hemodynamic parameters were measured using impedance plethysmography: mean blood pressure, heart rate, minute cardiac volume, total peripheral resistance, work performed by the left ventricle, and blood perfusion in the vessels of the head, upper and lower lobes of the lungs and liver. Immersion alone led to the following changes, statistically significant with respect to baseline levels in one or more sessions: increase in heart rate, decrease in work performed by left ventricle, increase in blood perfusion in the head and lungs, and decrease in blood perfusion in the liver. During positive pressure breathing sessions, the following results, statistically significant in one or more sessions with respect to parameters during immersion alone, were obtained: increase in blood pressure, increase in heart rate, decrease in minute volume, increase in peripheral resistance, decrease in left ventricle work, decrease in blood perfusion in the head, and upper and lower lobes of the lung, and increase in blood perfusion of the liver. Changes in blood perfusion and blood pressure due to positive pressure breathing were in the opposite direction from changes in these parameters attributable to immersion; thus, the breathing treatment tended to normalize the effects of simulated weightlessness for these parameters. After breathing sessions were completed, parameters returned to their pre-session values. Effects of positive pressure breathing on blood pressure, minute volume, peripheral resistance and ventricle work tended to diminish from the first to the third sessions. Effects on blood perfusion remained virtually identical across the three breathing sessions. The authors consider this study important to the utilization of older individuals in space.

Table Titles: Table 1: Changes in major hemodynamic parameters

Table 2: Effects of positive pressure breathing session on measurements of central hemodynamics as a function of length of exposure to immersion

P159(12/85)* Krasnykh IG, Gaydamakin NA, Petrukhin VG. Functional [determined using X-rays] and pathological morphological changes in the hearts of dogs undergoing six months of hypokinesia. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 41-45. [13 references; 3 in English] Affiliation: Not available

Cardiovascular and Respiratory Systems, Heart, Atrophy; Histology
and Morphology, Cardiac
Dogs
Hypokinesia, Immobilization

Abstract: Eight dogs, aged 3-5 years, of both sexes were held in immobilization cages for 6 months. Three additional dogs served as controls. Before the immobilization period, on days 15 and 30 during this treatment and every month thereafter, the animals were X-rayed to determine the systolic and diastolic heart size and the contractility of the myocardium. After 6 months, six of the dogs were sacrificed and samples of the myocardium of the right and left ventricles were obtained. The other two dogs were treated identically after a 30-day recovery period. Cardiac tissues were examined with an electron microscope and histochemically. Diastolic and systolic heart size and stroke volume had decreased substantially after 15 days of immobilization, continued to decrease until the third or fourth month and then leveled off. By the end of the 6-month period, heart size had decreased by 20% and stroke volume by more than 35%. The X-rays showed evidence of decrease in the contractility of the myocardium, increasing with duration of immobilization. The animals allowed a 30-day recovery period demonstrated recovery of 50% of the losses in heart size and stroke volume; similar incomplete recovery was observed in the signs of contractility. Microscopic examination of the myocardia revealed some narrowing of the lumen of the blood vessels and evidence of atrophic changes. Evidence of focal destruction was found in the myofibers and mitochondria. These changes were more pronounced in the left ventricle. Histochemical analysis revealed decreases in the activity of dehydrogenase succinate, alpha-glycerophosphate, NAD-H₂ glutamate, dihydroorotase and inosine-5-phosphate, and increases in the activity of monoamine oxidase, alkaline and acid phosphatase. These changes indicated that the attenuation of the contractile function of the myocardia was associated with a pronounced decrease in the amount of energy generated. After 30 days of recovery these structural changes had been only partially reversed.

Table and Figure Titles: Table: The effect of hypokinesia on the size of the heart and cardiac index in dogs

Figure 1: Cardiac X-rays of dogs

Figure 2: Electron microscope image of the myocardia of dogs after 6-months of hypokinesia

P162(12/85)* Kokova NA. Hemodynamic parameters of individuals varying in tolerance to $+G_z$ (head-foot) acceleration. Kosmicheskaya Biologiya i Aviakošmicheskaya Meditsina. 19(5): 56-60. [9 references; 4 in English] Affiliation: Not available

Cardiovascular and Respiratory Systems, Hemodynamics; Also
Musculoskeletal System, Conditioning
Humans, Typology
Acceleration Stress

Abstract: Twelve individuals (not otherwise described) took part in this experiment. Each one was tested from one to seven times. Subjects were rotated in a centrifuge which created a constantly increasing acceleration force (growth rate = 0.003 g/sec) in the head to foot direction. Rotation continued to the limit of each individual's tolerance, as determined by standard physiological parameters and verbal feedback. No countermeasures were used, but subjects were required to exert pressure with the muscles of their abdomens and lower extremities. The following physiological measurements were made during the test: EKG (three contact points), systolic blood pressure in the vessels of the ear lobes, stroke and minute volumes (using impedance plethysmography of the heart). Visual disturbances were also reported. Subjects' reactions to test sessions were divided into three groups on the basis of acceleration tolerance levels. In high tolerance sessions (N=16) maximum tolerated acceleration averaged 4.93 units (range: 4.6-5.6), moderate tolerance sessions (N=21) involved mean maximum acceleration of 4.34 units (range: 3.8 to 4.6) and low tolerance sessions (N=4) had a mean maximum acceleration of 3.7 units. The tolerance level of some individuals varied from session to session. Up to an acceleration of 1.4 units, individuals in all groups exhibited a drop in minute volume to below baseline. High tolerance of acceleration was associated with a subsequent increase in minute volume. This was also the case for moderate tolerance, but here the increases were less pronounced. Low tolerance sessions were characterized by further drops in minute volume to 50-65% baseline level. In high tolerance sessions, minute volume increased as a function of heart rate (which rose by 86%), while stroke volume remained relatively constant. Visual disturbance was reported in only one case. In moderate tolerance sessions, drop in stroke volume with increasing acceleration was somewhat more pronounced. At approximately 3.2 units, minute volume began to drop and heart rate increase did not compensate for decreasing stroke volume. Visual disturbances occurred in 33% of the cases classified as moderate tolerance. In low tolerance sessions, the drop in stroke volume was so great that substantial increases in heart rate maintained constant minute volume only up to a force of 2.2 units. Visual disturbances occurred in all cases classified as low tolerance. Examination of the data indicates that a drop in minute volume to 50-70% of baseline is accompanied by visual disturbances most of the time. Individual differences in tolerance are attributed to ability to maintain muscular tension with the abdomen and legs.

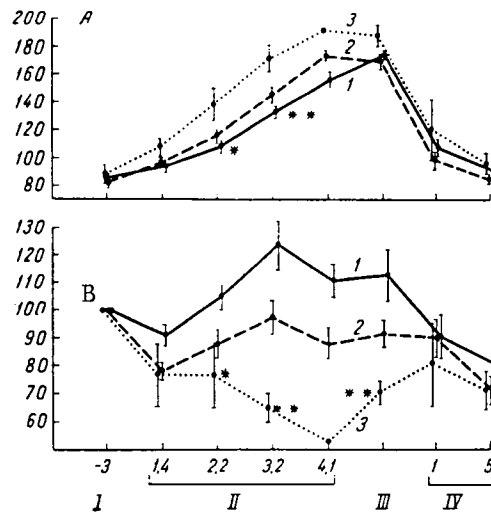


Figure Titles: Figure 1: Heart rate and minute volume under $+G_x$ acceleration in individuals varying in tolerance

1, 2, 3 -- high, moderate and low tolerance sessions, respectively

* $p < 0.02$; ** $p < 0.01$. Here and in Figure 2, Abscissa: I - 3 minutes before acceleration; II - exposure to $+G_x$ (in units); III - deceleration of centrifuge; IV - minutes 1 and 5 after acceleration.

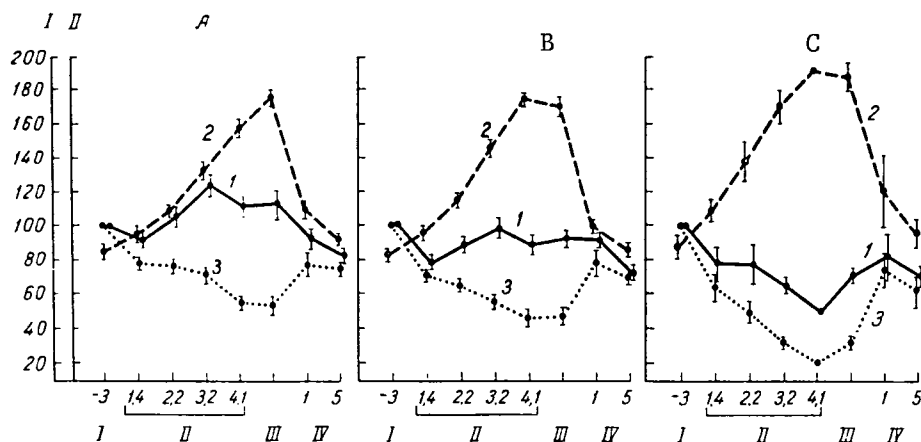


Figure 2: Stroke and minute volume and heart rate under $+G_z$ acceleration in sessions associated with high (A), moderate (B) and low (C) tolerance. 1 - Minute volume. 2 - Stroke volume, 3 - Heart rate.

Figure 3: Occurrence of visual disturbances as a function of decrease in minute volume at acceleration of $+4.1 G_z$

P164(12/85)* Lapayev EV, Bednenko VS. The cumulative effect of Coriolis acceleration on coronary hemodynamics. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 64-67. [17 references; none in English] Affiliation: Not available

Cardiovascular and Respiratory Systems, Hemodynamics, Coronary;
Neurophysiology, Vestibular System
Humans
Acceleration, Coriolis

Abstract: Two experiments were performed on healthy individuals aged 28-30. In the first experiment, 29 subjects were seated in a vestibulometric chair and subjected to gradually increasing Coriolis acceleration, which was terminated at the appearance of Level III vestibular reactions or after 15 minutes. Electro- and ultrasound cardiographical measurements were made. Heart rate was determined from the former, and changes in effective coronary circulation were determined from the latter. Parameters associated with stroke and minute cardiac index and volume were calculated. In the second experiment, the combined effects of Coriolis acceleration and acute hypoxia were studied. Hypoxia was induced by 30 minutes of prebreathing a nitrogen-oxygen mixture containing 10.5% oxygen which continued throughout the acceleration. In the first experiment, 27/29 subjects experienced Level III reactions at times ranging from 1 to 29 minutes. During acceleration the stroke cardiac index increased, reaching as high as 2.3 times baseline value; however, values were higher during less severe levels of vestibular reactions than during more severe ones. This was also the case with the minute cardiac index, which reached a maximum of 2.88 times baseline value during Level I reactions, but dropped to 2.17 times baseline value during Level III reactions. Values for both these indices dropped, but did not reach baseline values during a 5 minute recovery period. Slight and statistically nonsignificant drops in both volume parameters were observed during acceleration. The authors describe these increases in cardiac indices under acceleration as adaptive with regard to increased requirements for oxygen by myocardium during acceleration and suggest dilation of coronary vessels as the most likely underlying mechanism. However, since the metabolic need of the myocardium for oxygen does not decrease during severe vestibular reactions, the tendency of coronary indices to drop may result in coronary insufficiency in response to acceleration. In the second experiment where acceleration was accompanied by acute hypoxia, both cardiac indices increased during acceleration but the level of increase was directly, not inversely, associated with severity of the vestibular reaction. After 5 minutes of recovery, cardiac indices were still high. As was the case with no hypoxia present, there were no significant changes in volume indices. The contributing effects of hypoxia on cardiac parameters during acceleration are considered to be favorable, since they would tend to prevent the occurrence of cardiac insufficiency.

Table Title: Changes in hemodynamic indices during exposure to continually increasing Coriolis acceleration and acute hypoxia

P166(12/85)* Gorozhanin VS. Individual differences in regulation and level of maximum oxygen uptake. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 72-77. [18 references; 9 in English] Affiliation: Not available

Cardiovascular and Respiratory Systems, Maximum Oxygen Uptake
Humans, Males; Typology
Neurological and Hormonal Systems

Abstract: Maximum oxygen uptake is a useful predictor of how a person will react physiologically to extreme conditions and is used for astronaut selection by NASA. In this study, EEGs, reaction time and changes in blood pressure were measured in 59 male non-athletes aged 18-28 in response to five levels of sound. The individuals were divided into groups on the basis of the values of these parameters. Group 1 consisted of 28 men whose EEGs showed high levels of delta and theta wave activity, low levels of alpha wave activity, low sensory thresholds, and low ratio of blood pressure response to a sound of 40 decibels to blood pressure response to a sound of 120 decibels. Group 2 consisted of 31 men with the opposite values (see Table 1). Measurement of maximum oxygen uptake based on standard parameters was performed during and after a strenuous treadmill exercise test. In addition, blood was drawn before and after exercise and concentrations of ACTH and somatotropin, hydrocortisone, insulin and 11-hydroxycorticosteroids were measured. Before and 3 and 30 minutes after exercise, blood lactate, pyruvate and glucose were measured, along with excretion of epinephrine, norepinephrine, dopamine and DOPA. Members of Group 2 demonstrated higher values for maximum oxygen uptake and associated parameters, e.g., pulmonary ventilation, than did members of Group 1. Subjects in Group 1 responded to the exercise stress with increased excretion of epinephrine and decreased norepinephrine excretion, decreased excretion of dopamine with no changes in DOPA excretion, increases in blood concentration of ACTH, hydrocortisone and total and free 11-hydroxycorticosteroid; some increase in the concentration of somatotropin; a large decrease in insulin concentration, a smaller increase in peak concentrations of lactate, pyruvate and glucose and a sharp drop in blood pH. Members of Group 2 manifested a response pattern to exercise stress that was diametrically opposed to that exhibited by members of Group 1 (see Table 2). The authors argue that results indicate the importance of hormonal and neuroregulatory mechanisms in determining an individual's maximum aerobic potential. Individual differences in these mechanisms lead to individual differences in level of maximum oxygen uptake. Hormonal factors identified as leading to high aerobic potential include: 1) Relatively low baseline levels of epinephrine, ACTH, hydrocortisone, and 11-hydroxycorticosteroid and high levels of norepinephrine. All these lead to optimum glycogenolysis rate, high minute blood volume, stabilized heart rate and an increase in lipolysis, (since norepinephrine stimulates lipolysis, O_2 utilization and bradycardia without affecting glycogenolysis); 2) Smaller decreases in insulin concentration in response to exercise, (since one of the functions of insulin is to block glycogenolysis); 3) Higher initial levels of somatotropin hormone which acts to stimulate lipolysis and oxidation of fatty acids, thus lowering the utilization of glucose by the muscles and increasing the respiratory index. Individuals for

whom the activating effects of the reticular-hypothalamic-amygdalic systems dominate the inhibiting effects of the cortical-striatic-septic-hippocampal-epiphyseal systems tend to exhibit these hormonal effects leading to low maximum oxygen uptake. This pattern was directly identified in the EEG and blood pressure response tests in individuals of Group 1.

Table 1. Electrophysiological, sensory and cardiorespiratory parameters of subjects

Parameter	Subject Group	
	1	2
EEG Delta wave energy, mkW•sec	73.3	37.1
EEG theta wave energy, mkW•sec	61.0	35.5
EEG alpha wave energy, mkW•sec	57.5	187.4
Threshold for tactile electrical stimulation, W	1.22	11.3
BP to sound of 40 decibels, 1 kHz, ms	154	209
BP to sound of 120 decibels, 1 kHz, ms	130	122
Ratio BP ₄₀ :BP ₁₂₀	1.19	1.72
Coefficient b	-0.21	-1.16
Absolute VO _{2max} , l/min	2.88	3.49
Relative VO _{2max} , ml/kg.min	42.4	53.1
Pulmonary ventilation, l/min	111	119
Exhalation of CO ₂ , l/min	3.24	3.78
O ₂ utilization, %	3.09	3.71
Respiratory coefficient	1.12	1.08
Maximum energy production, cal/min	14.4	17.5
Maximum energy production, cal/kg min	211	266
Heart rate during V _{O2max} per minute	201	194
O ₂ -pulse, ml/beat	14.7	18.0
Ventilation equivalent for O ₂	37.2	34.1
Oxygen debt, l	5.88	6.62

All differences between groups significant at $p < 0.01$.

Table 2. Hormonal-metabolic parameters in subjects in groups 1 and 2 before, during and after physical exercise

Parameter	Subject Group					
	1			2		
	Before Exercise	During Exercise	30 minutes After	Before Exercise	During Exercise	30 min. After
Excretion of: (in ng/min)						
Epinephrine	6.8	19.4		5.2	14.5	
Norepinephrine	7.1	1.5		8.0	22.1	
Dopamine	533	501		568	607	
DOPA	8.6	9.4		11.4	18.5	
Concentration of:						
ACTH, pg/ml	81.4	331	92.7	55.1	275	63.5
Hydrocortisone, ug per 100 ml	11.7	18.8	17.9	9.2	10.4	11.1
Total 11-OHCS, ug per 100 ml	21.2	28.6	26.8	16.1	19.3	19.0
Free 11-OHCS, ug per 100 ml	4.9	7.5	6.6	2.4	2.9	2.8
Somatotropin, ng ml	1.9	7.3		2.8	12.4	
Insulin, mkED/ml	22.1	8.1		17.0	11.8	
Lactate, mg per 100 ml	10.5	96.1	39.4	16.3	105.5	28.6
Pyruvate, mg per 100 ml	0.77	2.0	1.08	0.85	3.1	1.01
pH of blood	7.37	7.09	7.26	7.35	7.19	7.32
Glucose, mg per 100 ml	85.4	88.9	86.7	82.6	79.4	83.4

All intergroup parameter values differ significantly ($p < 0.05$) for each measurement point with the exception of glucose concentration

Figure: Examples of changes in the characteristics under study in members of Groups 1 and 2

MONOGRAPH

M39(12/85) Amosov NM, Bendet YaA. Fizicheskaya aktivnost' i serdtse. [Physical activity and the heart]. Second edition, revised and expanded. Kiev: Zdorov'ya; 1984. [232 pages; 34 tables; 54 figures; 47 references; 12 in English]

Affiliation: USSR Academy of Sciences; Kiev Scientific Research Institute of Cardiovascular Surgery.

Key Words: Cardiovascular and Respiratory Systems, Cardiovascular Conditioning, Physical Exercise; Human Performance, Work Capacity

Annotation: This book contains information about the effect of physical activity on cardiovascular functioning and its role in the prevention and treatment of cardiovascular diseases. The physiology of physical stress is also discussed. Particular emphasis is given to the use of modern stress tests for assessing the functional performance of the cardiovascular system. The authors present the general rules for conducting occupational examinations and make recommendations for evaluating the work capacity of patients with cardiovascular pathology based on their level of cardiovascular conditioning as determined on the basis of stress test results. A prominent section is devoted to recommendations for a training program to prevent cardiovascular and other diseases, and to provide physical rehabilitation of individuals who have had surgery for a heart abnormality and patients with chronic coronary insufficiency. This second edition contains some necessary revisions and the section on the physical and occupational rehabilitation of patients has been revised and expanded. This book is intended for physicians with various fields of specialization who are interested in the prevention and treatment of cardiovascular illnesses.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Chapter 1. Physiology of physical stresses (3)

General issues relevant to hemodynamic change in response to physical stresses (7)

Heart rate (9)

Cardiac stroke volume (12)

Cardiac minute volume (13)

Blood pressure (15)

Vascular resistance (16)

Regional circulation (17)

Gases and pH of the blood, hematocrit (20)

Intracoronary circulation (21)

Pulmonary function (23)

Oxygen consumption (24)

Energy expenditure (29)

Physical work capacity (30)

Terminology, units of measurement, energy equivalents (31)

Chapter 2. Stress tests in the assessment of the functional performance of the cardiovascular system (34)

Recovery tests (35)

Submaximal tests of effort (37)

Preparation and conduct of stress tests (38)

Ensuring the safety of stress tests (40)

Obtaining and evaluating information on the state of the cardiovascular and respiratory systems during stress tests (43)

Selection of loadings (49)

Stair test (52)

Bicycle ergometer test (56)

Treadmill test (60)

Chapter 3. Major methods for evaluating the results of stress tests (65)

Astrand-Riming Nomogram (65)

Anderson and Smith-Silverstein Graph (70)

Shephard nomogram for evaluating treadmill tests (71)

Using formulas to determine maximal consumption of oxygen and physical work capacity (72)

Electrocardiographic evaluation of stress tests (76)

Electrocardiographic signs of coronary insufficiency during stress tests (77)

Chapter 4. Using results of stress tests to perform energy assessments of physical state and work capacity (84)

Using stress tests to assess the energy demands of physical activity and determine work capacity (84)

Energy gradations of the physiological state of healthy individuals and patients with cardiovascular diseases (94)

Chapter 5. Physical activity in the prevention of heart disease (109)

Civilization and cardiovascular diseases (109)

Certain general biological aspects of training (109)

The effect of physical training and hypodynamia on hemodynamics (133)

General methodological issues related to physical training (141)

Physical training programs (146)

Chapter 6. Physical and occupational rehabilitation of patients with cardiovascular diseases (160)

Goals and methods of rehabilitation (160)

Physical rehabilitation (166)

General requirements for physical rehabilitation programs (168)

Physical rehabilitation programs (172)

Methods and results of physical rehabilitation of patients who have had heart surgery (180)

Principles of occupational rehabilitation (188)

Conclusion (201)

Appendix (209)

References (228)

BOOK REVIEW

BR5(12/85) Zhironkin AG. Review of: Breslav IS. Patterny dykhaniye: Fiziologiya ekstremal'nyye sostoyaniye, patologiya [Patterns of respiration: Physiology of extreme conditions, pathology]. Leningrad: Nauka; 1984. In: Fiziologicheskiy Zhurnal SSSR imeni I.M. Sechenova. LXXI(8): 1036-1039; 1984.

Note: An abstract of this book [M18(8/85)] was published in Issue 2 of this digest.

Key words: Cardiovascular and Respiratory Systems, Respiration, Extreme Conditions, Hyperbaria, Stress, Exertion, Hyperthermia

The term respiration pattern is an unfamiliar one to physiologists. On the other hand, it would be virtually impossible to express all the aspects of this concept's meaning (respiration rate and depth, the duration and nature of inhalation and exhalation, etc.) with another term.

In this regard, the author of the book being reviewed has performed a valuable service. Not only has he presented a detailed overview of the enormous number of publications relevant to respiration patterns, but he has also introduced a number of new concepts. These include the two types of reorganization of the respiratory cycle, isoventilatory and stenoventilatory, and a typology of human respiration patterns, normopnoic, taxipnoic and bradipnoic.

Using modern concepts, this monograph provides a thorough analysis of the neurophysiological, humoral and biomechanical mechanisms of respiration patterns in various physiological states (rest, sleep, stress) and under various functional stresses (physical and mental exertion, hyperthermia, etc.).

The data cited in the text, including results obtained by the author himself and by his colleagues, are well illustrated. A subject index is provided for the reader's convenience.

It should be emphasized that the audience to whom this monograph will prove useful is not limited to theoretical physiologists. The author also discusses such practical problems as respiration under hyperbaric conditions, under excess intrapulmonary pressure and other extreme conditions, and also in pathological states. (A separate section is devoted to the diagnostic and prognostic implications of respiration patterns.) For this reason, I.S. Breslav's book should interest specialists in sport and occupational physiology, aerospace and submarine medicine and, certainly, practicing physicians.

CYTOLOGY

(SEE ALSO MICROBIOLOGY: P182; DEVELOPMENTAL BIOLOGY M43;
MATHEMATICAL MODELING: M41)

PAPER

P180(12/85) Sushkov FB, Mal'ts V, Kopp F, Pitra K, Rokov A, Rudneva SV, Stolley P, Tolkendorf Ye, Fender Kh, Yunge G. Experiment in culture of mammalian cells on the "Salyut-6" -- Soyuz-31" space complex. In Dubinin NP, editor. Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 55-59. (See Issue 1 of Digest, pp. 66-69.)

Cytology, Cytogenetic Parameters
Mammalian Cells, Hamsters
Space flight, Salyut-6

Abstract: This study, which was performed jointly with the GDR, used Chinese hamster V79-4 cells. The karyotype of the modal class of cells carries 22 well identified chromosomes; the mean doubling time for these cells is approximately 14 hours. V79-4 cell culture growth is accompanied by the formation of cellular aggregates, called spheroids, which are considered to be a model of primitive tissue complexes. The cells were cultured in 30-ml plastic vials filled with a pH controlled medium containing 10% calf serum. One thousand cells were added and after a short incubation period the containers were cooled to 20°C. Subsequently, the cells were transported to the spacecraft (duration: ca. 24 hours) at 4°C. After they were loaded on board the space station, active growth of the culture continued for 138 hours at a temperature of 37°C. During this period nine cell divisions occurred. Three control conditions were used; each utilized the same suspension and was identical to the experimental condition in all aspects of treatment other than exposure to the flight environment. The first was located in the laboratory in Berlin, the second and third in the USSR. In the third control condition, the cells were cultured at 37°C for 143 hours.

Visual inspection revealed no distinction between experimental and control cultures. Microscopic analysis, however, revealed that the experimental cultures contained substantially fewer macrocolonies and many spheroids of various sizes (Table 13). The majority of these were about 100 um in diameter and contained approximately 1000 cells. Evidently these formed from cells detached from the substratum during transport of the culture. The smaller spheroids evidently formed from the cells peeling off the walls of the vessel under weightlessness. The colonies which formed during weightlessness were larger in diameter than the controls, but were distributed in clumps and in smaller quantities. Electronic analysis indicated lower cell density in the experimental cultures. Space flight conditions did not influence the electrophoretic properties of the cells. Both experimental and control cultures showed a higher level of chromosomal aberrations than is typical of cultures grown under laboratory conditions. These are attributed to various non-manipulated aspects of the procedures, such as changes in temperature. In the other cytogenetic indicators tested, including the number of cells resistant

to azoguanine and repair of DNA after exposure to 100 rads of radiation, the experimental cultures did not differ from the control. Light microscopy revealed no noticeable changes in the shape and size of cells after space flight. The number of anomalous mitoses remained within normal limits. Changes over time in cell population density, and relationships between phase of mitosis and degenerative processes were identical for experimental and control conditions. However, the mitotic index for the postflight population of cells was higher in at least one of the experimental subcultures. The electron microscope revealed that the experimental cells adhered more closely to the substratum and that surface structures were less pronounced than in the controls. There were more RNA-containing viral particles in the experimental cells, leading to the conclusion that reproduction of endogenous viruses occurs more rapidly under weightlessness than under normal gravitation. For one experimental subculture, the average size of cell nuclei was larger by approximately 10% than cells in the control subcultures. These results are interpreted as indicating that flight factors do not induce major (irreversible) changes in "free living" mammalian cells. However, when cell populations form under weightlessness, there are evidently some cytophysiological shifts which can be detected after subsequent culturing of the cells on Earth.

Table 13; Cytological parameters of the cultures after termination of the experiment

Condition	Macrocolonies	Number Spheroids Per Vial	Cells X 10 ⁵
Control			
I	126	20	8.8
II	122	20	7.8
III	120	20	6.6
Mean	122.7	20	7.75
Experimental	90	238	5.2

Table 14. V79-4 Cell Multiplication Rate Parameters

Condition	Parameter	Subculture					
		Day 3	I Day 5	Day 7	II Day 1	Day 3	III Day 3
Control	Population density*	18.5	403.7	724.1	74.0	285.4	327.2
	Mitotic index	7.2	13.4	8.3	22.7	27.3	25.4
	M/P**		1.95		2.76	2.0	2.34
	P+M/A+T		2.61		2.38	2.0	2.13
	Pycnotic and anomalous*** cells, %					12.3	11.0
Experi- mental	Population density	20.5	326.5	716.2	97.0	325.2	292.3
	Mitotic index	9.7	16.9	10.0	25.4	30.7	20.7
	M/P		1.69		3.28	2.1	2.1
	P+M/A+T		2.41		2.62	2.2	2.24
	Pycnotic and anomalous cells, %					15.6	12.5

* Population density is expressed in number of cells $\times 10^5$ for Day 3, Subculture I and in kl/mm^2 for all other cases. ** P,M,A,T are the phases of mitosis. *** Anomalous cells include polynucleate, fragmentary and giant.

Table 15. Results of karyometry of V79-4 cells

Subculture	Duration of Cultivation	Condition	cell nucleus μm^2	p	$\pm\%$
1	3 days	Control I	80.2	< 0.001	-12
		II	81.7	< 0.001	-10
		III	82.8	< 0.005	-8.5
		Mean	82.2	< 0.005	-9.5
		Experimental	89.9		

DEVELOPMENTAL BIOLOGY

PAPER

P176 (12/85). Kokorin AI, Pigareva MD, Pal'mbakh LR, Afanes'yev GD, Mashinskiy AL. Embryological development of the domestic quail under conditions of weightlessness. In Dubinin NP, editor, Biologicheskoye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 139-141. (See Issue 1 of Digest, pp. 66-69 for abstract of this book.)

Development, Embryology

Birds, Quail

Space Flight, "Salyut-6," Weightlessness

Abstract: Because the biological effects of gravity are biomechanical and thus depend on the linear dimensions of the system being influenced, embryological effects were considered most likely to be observable in birds, whose eggs are larger by two or three orders of magnitude than the oocytes of other vertebrates. It has been well established that the egg can only develop normally when it is properly oriented to the gravitational axis. In this experiment, 11 eggs of the domestic quail were transported to the "Salyut-6" orbital station and placed in a container with a constant temperature of 37.5° and relative humidity of 65-80%. Cooler air was blown on the eggs for 10 minutes daily and the container was shaken lightly. After 2.5 days of incubation, seven of the eggs were removed and returned to Earth. The remaining four eggs were incubated for an additional 24 days, after which three of them were fixed in a formaldehyde solution and returned to Earth, while the remaining egg was opened and examined by the cosmonauts. Embryonic development was compared to eggs from the same batch incubated in an identical manner on Earth. The first group of eggs (incubation period of 2.5 days) was found to be 3 hours behind their control counterparts in development. This was tentatively attributed to the amount of time required to equilibrate them to chamber temperature after they were placed inside. Of the seven embryos, five were oriented normally, i.e., the body axis corresponded to the short axis of the egg, with the head to the right. Of the two embryos abnormally positioned in the egg, both exhibited asymmetry of the area vasculosa and developmental defects, one being microcephalic and the other acephalic. No such anomalies were found in the control embryos. Of the four eggs incubated for a longer period, one embryo had stopped developing at a stage corresponding to about 6 days of incubation and was positioned abnormally in the egg. The three remaining embryos had continued to develop. Two were abnormally positioned in the egg in a way which could potentially have led to death.

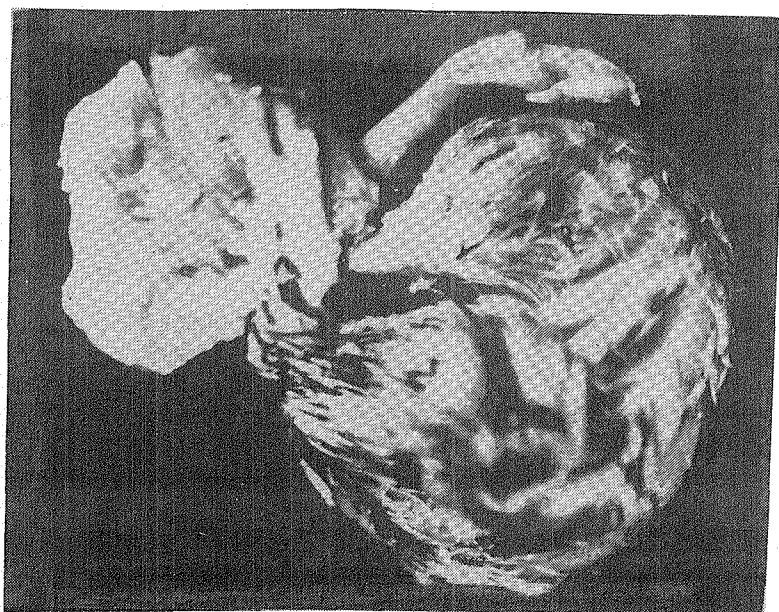


Figure Title. Domestic quail embryo which developed under weightlessness (stage of development approximately 13 days)

MONOGRAPH

M43(12/85) Kusen' SI, Stoyka RS. Molekulyarnyye mekhanizmy v deystvii polipeptidnykh faktorov rosta [Molecular mechanisms in the operation of polypeptide growth factors]. Moscow: Science; 1985. [240 pages; 20 Tables; 68 Figures; 1292 references; 1264 in English]

Affiliation: USSR Academy of Sciences, N.K. Kol'tsov Institute for Developmental Biology

Key Words: Developmental Biology, Embryogenesis, Polypeptide Growth Factors; Cytology, Cell Proliferation; Genetics and Embryology

Annotation: This book summarizes the latest results in the study of the molecular mechanisms for regulating cell proliferation. The authors consider information on the structure and properties of the majority of identified polypeptide growth factors and data on the growth of target cells. They discuss the functional significance of the formation of growth factor complexes with receptors, the role played by peptide "secondary messengers" in the regulation of aspects of metabolism, synthesis of polypeptide growth factors, and the regulatory effects on animal and human cells in embryogenesis, and malignant growth. This book is intended for specialists in molecular biology, biochemistry, cytology, genetics and embryology.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Introduction (2)

Chapter 1. Polypeptide factors regulating cell proliferation (5)

Somatotropin and the related polypeptides -- prolactin and placental lactogen (5)

Somatomedin (7)

Insulin (17)

Epidermal growth factor (23)

Growth factor for nerves (26)

Growth factor for fibroblasts (31)

Growth factor for thrombocytes (33)

Growth factor for cartilage (35)

Factors stimulating growth of colonies of granulocytes and macrophages (36)

Growth factor for T-cells (40)

Erythropoietin (41)

Lectin (42)

Other polypeptide factors affecting cell proliferation (43)

Transforming growth factors (47)

Polypeptide inhibitors of cell proliferation (50)

Nonpeptide regulators of cell proliferation (53)

Chapter 2. Specialized interaction of polypeptide growth factors and receptors in plasma cell membranes (59)

Receptor structure (59)

Kinetics of the binding of growth factors and receptors (69)

Chapter 3. Internalization of ligand-receptor complexes (84)

Lateral motion of ligand-receptor complexes on the plasma membrane and the formation of clusters (88)

Intracellular penetration of ligand-receptor complexes (internalization) (88)

Intracellular transformation of ligand-receptor complexes (94)

The role of cytoskeletal elements in the internalization of ligand-receptor complexes (101)

Intracellular receptors of polypeptide growth factors (106)

Functional significance of internalization and intracellular transformation of ligand-receptor complexes (108)

Chapter 4. The effect of polypeptide growth factors on cell metabolism (116)

Regulation of transport of ions and certain substrates through the plasma membrane (116)

The effect of polypeptide growth factors on the level of cyclic nucleotides and on the activity of cyclase systems in the cells (130)

The effect of polypeptide growth factors on biosynthesis and decomposition of nucleotide acids (133)

The effect of polypeptide growth factors on phosphorylation and functional activity of proteins (137)

Induction of ornithine decarboxylase. The role of polyamines in the regulation of metabolism (141)

Chapter 5. Regulation of cell proliferation in embryogenesis (155)

Formation of polypeptide growth factors by cells during embryogenesis (155)

Sensitivity of embryonic cells to polypeptide growth factors (160)

The effect of polypeptide growth factors on differentiation of embryonic cells (164)

Conclusion (167)

References (170)

List of abbreviations and symbols (228)

Subject index (229)

ENDOCRINOLOGY

(SEE ALSO: HISTOLOGY: P144; MATHEMATICAL MODELING: M41)

PAPER

P146(12/85) Morenkova SA. Insulin-receptor interaction with plasma membranes of hepatic and muscle cells in rats with generalized infections. *Patologicheskaya Fiziologiya i Eksperimental'naya Terapiya*. 1985(4): 43-46. [14 references; 12 in English]

Endocrinology, Insulin, Insulin-Receptor Interaction
Rats
Disease, Infections, Countermeasures, Indomethacin

Abstract: The goal of this study was to evaluate the state of insulin receptors under conditions of generalized infection accompanied by impaired glucose utilization. Since the increased production of prostaglandins in infection also inhibits insulin secretion, the effect of indomethacin, an anti-inflammatory drug, which acts as an inhibitor of prostaglandin synthesis, on insulin-receptor interactions was also studied. Male rats weighing 150-180 g served as subjects. One group served as controls; the second group was infected with staphylococcus bacteria (*S. aureus*); and the third group, also infected with the bacteria, was given 1.5 mg/kg of indomethacin orally 1 hour before infection and twice a day for 3 days thereafter. On the fourth day, the surviving animals were sacrificed. Approximately 80% of the infected animals had died previously, while 85-90% of those given indomethacin had survived. Blood was taken from the rats and the concentration of glucose in the serum was determined. The cytoplasmic membrane was extracted from the liver and thigh muscles and the specific and nonspecific binding of ^{125}I -insulin with the receptors in the tissues was studied. Specific binding of ^{125}I insulin with the plasma membrane of the liver increased sharply in infected animals over that of the controls, particularly when a low concentration of insulin was present. Administration of indomethacin inhibited the amount of insulin-receptor binding. The quantity of receptors for 1 mg of insulin was 4, 7 and 5.8 pg/ml for the three groups, respectively. Similar effects, but of lesser magnitude, occurred in the thigh muscles. Here the quantity of receptors was calculated to be 2.8, 3.3, and 2.1 pg/ml for 1 mg of insulin. All three curves were parallel for both types of tissue, indicating analogous binding processes in spite of the increased number of receptors.

Figure Titles: Specific binding of insulin with plasmatic membrane of the liver and muscles

ENZYMOLOGY
(SEE ADAPTATION: P145; RADIOBIOLOGY: P149)

EXO BIOLOGY

PAPERS

P175(12/85) Mednikov VM. The monophyletic origin of life (the organic world) and the evolution of ecosystems. Zhurnal Obshchey Biologii. XLVI (4): 462-470; 1985. [14 references; 4 in English] Affiliation: Department of Biology, M. V. Lomonosov Moscow State University

Exobiology, Evolution of Ecosystem
Theoretical Paper
Origin of Life

Abstract: This paper argues for the monophyletic origin of life and describes the subsequent evolution of the Earth's ecosystem. It is asserted that the contrary hypothesis, that of the polyphyletic origin of life, depends on the concept that a stable ecosystem cannot be based on a single organism. In turn, this position depends on the idea that only closed ecosystems are stable. The author argues that, on the contrary, only ecosystems which are open from the standpoint of exchange of matter are stable. Such systems depend on the continuous flow of organic materials or reduced and slightly oxidized inorganic ones (such as CH_4 , H_2 , H_2S , Fe^{++} , NH_3 , NO_2 , etc.) The author starts with the hypothesis that, given the presence of a stable electron donor, an electron acceptor -- the protoorganism -- developed monophyletically and evolved through divergence. In the course of this evolution the ecosystem became more complex until it reached a level optimal for this planet. The author's further arguments predicate three stages of evolution, which he describes as triggered by the need to adapt to new adverse conditions. These stages are: 1) The population is defenseless against the new factor. (During this period, rigorous selection among existing forms occurs.) 2) As a result of this selection, adaptative variants are broadly disseminated throughout the population. 3) Selection continues among the adaptive variants, now favoring organisms which not only neutralize the new factor, but also can utilize it for their own benefit (e.g., as a source of energy, recombination, etc.). The author hypothesizes that the evolution of ecosystems progressed through addition to the food pyramid until it reached the limits of the possible, given the amount of radiation the Earth receives from the Sun. After this, (ca. 0.5 billion year ago) ecosystems evolved qualitatively, but not quantitatively.

The first primitive ecosystem consisted only of a producer and a reducer and involved anoxic photosynthesis, with the electron donor being H_2S , H_2 or an organic compound, and the source of carbon being CO_2 or the same organic compound of abiogenic origin. This first food chain, whose origin coincided with that of life, existed for 1.5 billion years at the minimum. Two and a half billion years ago the situation changed radically when a new group of producers, cyanobacteria, acquired the capacity to use H_2O as an electron donor, (i.e., photosynthesis became oxygenic). Whether or not the biogenic synthesis of oxygen was accompanied by abiogenic synthesis, about 2

billion years ago the concentration of this gas rose to 1% of its present value. This progressive growth in oxygen concentration enabled the development of eucaryotic cells, most likely from intracellular symbiosis between membraneless microorganisms and anaerobic bacteria, and their amalgamation into colonies -- the first multicellular organisms. These coral like colonies of stromatolites were common in the pre-Cambrian era but gradually disappeared, apparently because of the development of a new member of the ecosystem -- the first order consumer. These included the one-celled amoebae and infusoria, predatory fungi and the first multicellular animals. These consumers evolved relatively rapidly, mainly in the direction of utilizing various types of organic substances and a rich variety of different organisms evolved. About 570 million years ago, external and internal skeletons suddenly began appearing, consisting in different species of any of a variety of different substances and not attributable to chemical environmental changes. The author attributes the development of these skeletons to the appearance of second order consumers -- predators, marking the next stage in the development of the ecosystem.

The author emphasizes that the addition of each new change in the ecosystem entailed revolutionary changes not only in the biosphere but in the entire system of the Earth. If one accepts the premise of the biogenic origin of free oxygen, it follows that the Earth underwent three such revolutions. The first of these was associated with the development of oxygenic photosynthesis. The second stage was associated with the development of first order consumers, plant-eating multicellular organisms. The third was associated with the appearance of second order consumers (predators). Each new stage in development of the food chain occurred in half the time it took the previous one. It took no less than 1 billion years for the first order consumer to develop. During the preceding 2 billion years only the simplest ecosystems, consisting of two members (producer and reducer), existed. Multicellular predators -- second order consumers -- developed over the course of approximately 0.5 billion years after the appearance of multicellular plant-eaters. After the development of primitive predators, land ecosystems underwent no further structural development.

P177(12/85) Khenokh MA, Kuznetsova YeA, Tsupkina NV, Mashinskiy AL, Konyshin NI, Nechitaylo GS, Semenov YuP. Abiogenic synthesis of biological precursors during exposure to space flight factors. In Dubinin NP, editor, *Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut"* [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 21-25. (See Issue 1 of Digest, pp.66-69.)

Exobiology, Abiogenic Synthesis
 Biological Precursors, Nucleosides
 Space Flight, "Salyut-6," Cosmic Radiation Longterm Exposure

Abstract: Three dry mixtures -- adenine and ribose (I), adenine and deoxyribose (II), and thymine and deoxyribose (III) -- in molar proportions were placed in quartz ampoules and housed in a container attached to the outer surface of the "Salyut-6" Space Station for 10 months. The temperature during this time ranged from -50 to +50°C and total radiation exposure did not exceed 20 rad/year. Half of the ampoules were exposed to ultraviolet rays and sunlight, while the others were shielded from such radiation with a metal plate. Containers of the mixtures were also kept inside the station as a control. No nucleosides were formed in the control mixtures. After conclusion of the exposure period the mixtures were dissolved in hot water, filtered, subjected to Sephadex G-10 column chromatography and eluted. The fractions obtained were again subjected to thin layer chromatography and the elution volume, R_f , yield of nucleoside-like substances, and the molar ratio between base and hydrocarbons were determined for each fraction of each mixture. Peak absorption spectra for hydrolyzed fractions were found using UV spectrometry. Results for the mixtures not shielded from sunlight and UV radiation are shown in Tables 1 and 2. For the shielded sample yield of nucleoside-like substances was depressed substantially indicating the key role of the studied space flight factors (UV radiation and temperature shifts) in nucleoside formation. However, none of the native nucleosides which are components of nucleonic acids formed. All the compounds obtained had higher molecular weights than the nucleosides, adenosine, deoxyadenosine, and thymidine, and differed from them in values of R_f , λ_{max} , UV spectra, and ratio of base to hydrocarbons. The lack of nucleoside-like substance formation in compounds housed inside the station cabin indicates that weightlessness is not an important factor. The authors conclude that it is likely that purine, pyrimidine and hydrocarbons synthesized in space and adsorbed on interstellar dust, exposed to solar UV radiation and temperature changes undergo significant photochemical and thermal transformations including the formation of nucleoside like substances.

Table 1. Characteristics of nucleosides obtained through exposures of mixtures in quartz ampoules

Initial mixture	Compound	Elution volume to column of Sephadex G-10	R _f	Nucleoside yield, %	Molar ratio, Base: Hydrocarbon
I	A	34.5	0.85	6.6	1:3
	B	57.0	0.78	1.1	--
	C ₁	73.0	0.71	21.0	1:2
	C ₂	73.0	0.51	17.5	1:2
	C ₃	73.0	0.38	3.5	1:2
	Adenosine	99.0	0.68	--	1:1
II	D ₁	48.8	0.62	3.0	1:2
	D ₂	48.8	0.75	5.0	1:10
	E ₁	71.9	0.62	16.0	1:2
	E ₂	71.9	0.48	5.5	1:10
	Deoxyadenosine*	94.8	0.63	--	1:1
III	F	48.7	0.56	0.36	1:1
	Thymidine*	52.5	0.70	--	1:1

*Control substances

Table 2. Optical properties of nucleosides synthesized during exposure of mixtures as a function of pH

Initial mixture	Compound	λ_{\max}	λ_{\min} pH 1.0	λ_{\max}	λ_{\min} pH 6.0	λ_{\max}	λ_{\min} pH 10.00
I	A	271	238	267	234	268	242
	B	273	238	265	236	273	245
	C ₁	263	234	264	232	261	248
	C ₂	273	239	265	236	271	247
	C ₃	275	239	265	236	273	247
	Adenosine	259	230	262	228	261	237
II	D ₁	263	235	264	228	264	241
	D ₂	---	---	---	---	---	---
	E ₁	266	234	263	234	270	243
	E ₂	---	---	---	---	---	---
	Deoxyadenosine	260	229	261	228	262	235
III	F	272	239	273	239	272	248
	Thymidine	268	236	268	236	267	247

MONOGRAPH

M55(12/85) Rubenchik LI. Poisk mikro-organizmov v kosmose [Search for microorganisms in space (Second Edition; revised and augmented)]. Kiev: Naukova Dumka; 1983*. [111 pages]

Affiliation: Not available

Key Words: Exobiology, Microbiology, Space Flight Factors

Annotation: This book is devoted to one of the principle problems in natural sciences -- the existence of life in space. It cites the latest data from space biology, particularly space microbiology, pertaining to: the genesis of life on Earth; the origin of the microscopic organisms discovered on meteorites; the responses of microorganisms to extreme environmental conditions; the effects of space flight factors on their vital activity, etc. Particular attention is devoted to discussion of the existence of life on Mars. This book is intended for a general audience.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

What is "life"? (3)

"Wanderers from afar" (28)

The "hard" lives of terrestrial microorganisms in the laboratory and in nature (35)

Modeling ecological conditions on other planets (54)

Terrestrial search for extraterrestrial microscopic organisms (65)

Life on the Moon (81)

Is there life on Mars? (85)

Quarantine between Earth and space (105)

Recommended reading (111)

* Monographs cited in the Digest are usually intended primarily for scientific audiences and published within the last year. However, because of the scarcity of material in exobiology, we have relaxed these criteria in this case.

GENETICS: SEE DEVELOPMENTAL BIOLOGY: M43; RADIOBIOLOGY: P184

GRAVITATIONAL BIOLOGY: SEE BOTANY: P178, P179; DEVELOPMENTAL BIOLOGY: P176; MUSCULOSKELETAL SYSTEM: P161; NEUROPHYSIOLOGY: P160)

HABITABILITY AND ENVIRONMENT EFFECTS

PAPERS

P148(12/85) Vlasov VA, Vasil'yev GA. Predicting the toxicity of burning polymers. Gigiyena i Sanitariya. 1985(8): 18-21.
Affiliation: Not available

Habitability and Environment Effects, Outgas, Toxicity
Mathematical Modeling
Polymers, Burning

Abstract: This paper describes the result of a regression analysis of data from previous experiments determining the toxicity of burning polymers. The following outgas products were entered into the regression: CO, CO₂, HCN, HCl, SO₂, NO_x. The best fitting regression equation for predicting the critical weight of material the combustion products of which will, in a volume of 0.1m³, lead to a 50 percent death rate was: $Y = 4.83 - 2.36X$, where X is the amount of CO outgassed upon burning of 1 g of material. A short-cut method of dividing polymers into toxicity categories is also provided. Low toxic materials (critical weight less than 4000 mg) are those for which X is less than or equal to 0.5; toxic materials (critical weight between 1200 and 4000 mg) are those for which X is between 0.5 and 0.9; highly toxic materials are those for which X is greater than 0.9. An additional regression analysis was performed to predict the emission of carbon monoxide from a burning polymer containing carbon, hydrogen, and oxygen. Intermediate parameters included prediction of the temperatures at which the maximum exothermal effect occurs (TE_{max}) and active thermal decomposition of the material (TD) begins. The best fitting regression equation was:

$Y = 1.42X_1 - 0.18X_2 - 0.52X_3 + 0.74X_4 - 2.69X_5 - 1.28$;
where X₁-X₅ are the amount of gas emitted by 1 g of burning material for CO, CO₂, HCN, HCl, and SO₂ respectively.

P171(12/85)* Mishchenko VF, Zubov VA, Yeremenko YuG. Synthetic biocidal paints composed of high molecular metalloorganic compounds. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 89-92; 1985. [21 references; 5 in English]. Affiliation: Not available.

Habitability and Environment Effects, Paints, Metalloorganic compounds; Life Support Systems, CELSS
Fungi
Fungicidal Properties

Abstract: The most effective kind of biocidal paint for use in closed ecological life support systems are synthetic biologically active polymers, the biocidal effects of which are achieved through the presence of biologically active compounds linked to the polymer chain with hydrolytically unstable chemical bonds. In these compounds biocidal activity occurs only when conditions conducive to microorganism growth (increased temperature and humidity) occur. The most promising of these compounds appear to be organostannic compounds which are lethal to a broad spectrum of microorganisms, are highly effective at low concentrations and have an extremely low toxicity for warm blooded animals and humans. A number of such compounds were synthesized, varying in concentration of tin ranging from 0.0001 to 2 percent, and tested as fungicides. A range of fungi in massive doses were used as the test organisms and a nutrient substratum was used in half the cases. Fungicidal properties of the paints were assessed in accordance with procedures stipulated in a Soviet All-Union Standard. Results showed that the synthesized polymers are highly effective against fungi even when the tin content is reduced by an two or three orders of magnitude below that traditionally used (0.5 to 1 percent). Paints based on organostannic polymers, with tin content ranging from 0.0001 to 0.1 percent, not only provide protection from biodegradation for various systems susceptible to fungi, but also have a sterilizing effect which is crucial to the safety of closed life support systems.

Table and Figure Titles: Table: Fungicidal properties of paints made with organostannic copolymers of the (met)acrylate type

Figure: Paint samples after testing for fungicidal properties

HEALTH AND MEDICAL TREATMENT

(SEE BIOSPHERICS M53; MATHEMATICAL MODELING M34, M41; NEUROPHYSIOLOGY: M45)

PAPERS

M169(12/85)* Vlasov VV. [Effectiveness] of drugs and surfactants in preventing decompression sickness in rats. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 86-87. [8 references; 2 in English] Affiliation: Not Available

Health and Medical Treatment, Decompression Sickness

Rats

Drugs, Surfactants

Abstract: Since changes in the blood coagulation system and vascular reactions in response to free gas in the tissue are important factors in determining tolerance for decompression, this study attempted to identify drugs and surfactants which enhanced tolerance by acting on these processes. Twenty male albino rats were exposed in a barochamber to air pressure of 7 kgf/cm² [kgf=kilogram force] for 40 minutes. Pressure was then lowered to 5 kgf/cm² over 20 minutes, and to atmospheric pressure over 2 minutes where it remained for 5 minutes, and then was further lowered to 405 mm Hg over 5 minutes. Resistance to decompression sickness was estimated on the basis of mortality rate and observed severity of symptoms (using a rating scale). One hour before decompression, subgroups of rats (N=31-13) were administered interperitoneal doses of Trifluoperazine (5 mg per kg body weight), Phentolamine (5mg/kg), Raunatine (1mg/kg), Novocain (10 mg/kg), Diprazine (5mg/kg), Euphylline (10mg/kg), a mixture of Trifluoperazine, Phentolamine, Euphylline and Novocaine (1, 1, 1, 2 and 2 mg/kg respectively), a mixture of Trifluoperazine, Phentolamine and Euphylline (1, 1 and 2 mg/kg), or a mixture of Diprazine and Novocain (1 and 2 mg/kg). In other subgroups, Clofibrate (0.3 mg/kg) and Hydrocortisone (25 mg/kg) were introduced into the stomach with a catheter, and Corticosterone (0.3 mg/kg) was injected interperitoneally. Cortisone (10 mg/kg) was introduced into the stomach twice a day for the three days preceding decompression. For other subgroups (N=8-12), surfactants (alkylsulfonate, primary and secondary alkylsulfate and others) in 1% solutions (2 ml/ 100 g weight) were introduced into the stomach 30 minutes before decompression. Significant effects in diminishing severity of reactions to decompression were obtained with Trifluoperazine and Phentolamine alone and the Trifluoperazine/Phentolamine/Euphylline mixture. The latter had the greatest effect even though total drug intake was lowest. Clofibrate also had a substantial effect in diminishing severity of decompression symptoms, which the authors attribute to its counteractive effect on lipemia. None of the surfactants had a significant effect on these symptoms.

Table Title: Effects of various medicinal substances and antisurfactants on development of decompression sickness

P173(12/85)* Simonov LG, Drobakhin GA, Uoffe YuS, Safarov YuS, Talalayev YeG. A small piezo transducer with an elastic coating for continuous study of biological subjects. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 81-82. [6 references; 1 in English] Affiliation: Not available.

Health and Medical Treatment, Ultrasound
Equipment Development
Transducer, Piezo; Adhesive

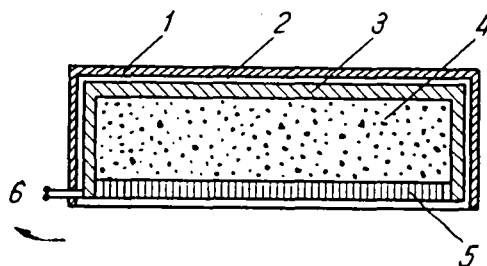
Abstract: The traditional method of performing ultrasound studies involves spreading oil on the subject to maintain acoustic contact, while the experimenter manually holds the transmitter in the proper position. However, this method has a number of limitations, particularly if continuous ultrasound recording over a period of time is to be performed. This paper describes the development and testing of a small piezo transducer and a nonfluid substance for maintaining reliable acoustic contact between the transducer and a biological subject. In the transducer, a piezoplate was covered with a quarterwave layer, damped by rubber on the other side, and placed in a container made of a material which effectively absorbs ultrasound waves. The entire device measured 33X28X8 mm. The material for the contact maintaining coating was developed from epoxy resin and carboxylated rubber. The transducer was tested with a low frequency ultrasound sphygmograph to record continuous sounding of the cranial vascular system of 90 individuals. The transducer remained in place even when subjects moved or changed their positions. Comparison of results obtained with the transducer and results on the same subjects using traditional ultrasound techniques indicated that the newer device did not alter or distort the signals.

Table and Figure Titles: Table 1: Physical and mechanical properties of coatings

Table 2: Adhesive strength of coating materials

Figure: Diagram of the small piezo transducer

FIGURE



1 - outer container; 2 - epoxy layer; 3 - inner container; 4 - damper; piezoplate; 6 - lead conductors

HEMATOLOGY

PAPERS

P150(12/85) Raimzhanov AR. Characteristics of erythropoiesis in permanent inhabitants of high altitude regions. Zdravookhraneniye Kirgizii. 1985(4): 30-35. [References cited but not listed]
Affiliation: Department of Internal Diseases, Kirgiz State Medical School.

Hematology, Erythropoiesis; Also Adaptation, Long-term
Humans
High Altitudes

Abstract: Hematological parameters were examined in 373 permanent inhabitants of mountainous regions, with altitudes ranging from 760 m to 3600 m. The blood parameters of foothills inhabitants (760 m) were within the standard norms. However, inhabitants of moderately high and very high elevations showed an increase in the volume of red blood corpuscles. These individuals showed an increase in the quantity of hemoglobin per unit volume of blood and in individual erythrocytes, without a concomitant increase in number. In addition, some of the inhabitants of the highest altitudes showed elevation in the total weight of circulating erythrocytes. This increases the respiratory capacity of the blood.

P153(12/85)* Ushakov AS, Ivanova SM, Ataulakhanov FI, Pichugin AV, Dubinskaya YeI, Brantova SS, Labetskaya OI, Naydina VP, Zezerov AYe. Human erythrocyte metabolism during long-term space flight. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 19-23. [9 references; 3 in English] Affiliation: Not available

Hematology, Erythrocyte Metabolism
Humans, Cosmonauts
Space Flight, Long-term, Salyut-7

Abstract: Parameters of erythrocyte metabolism were studied in the two "Salyut-7" cosmonauts before and after their 150-day flight. Erythrocytes were extracted from peripheral blood and twice washed with a physiological saline solution. The concentration of ATP, glucose, glucose-6-phosphate (G-6-P), oxidized and reduced forms of glutathione, glycolysis rate, LDH and glucose-6-phosphate dehydrogenase (G-6-PD) activity were determined using spectrophotometry. Permeability of the erythrocyte membrane was studied by observing the rate at which K^+ entered the external medium. Stability of the erythrocytes was evaluated by observing the effects of mechanical and oxidizing stress. Mechanical stress was created with a peristaltic pump and oxidation stress through the introduction of tertbutylhydroperoxide. Lipid peroxidation was also studied. Lipids were extracted from the erythrocyte membranes and concentration of the primary and secondary products of lipid peroxidation was measured. The fatty acid components of the erythrocytic membranes were determined using gas chromatography.

On the first day postflight, a decrease was observed in rate of erythrocyte metabolism, as indicated by a drop in the rate of glucose consumption for one cosmonaut and in some decrease in the accretion of lactate when the erythrocytes were incubated in plasma or saline. At the same time, there was a tendency for the concentration of ATP to decrease. When the 5-phosphate metabolic path for glucose oxidation was examined, it was found that concentration of G-6-P was decreased. This could be explained by its increased oxidation in this path, as could the increase in G-6-PD activity also found. The authors suggest that these changes may have been directed toward supporting redox processes in the cell, particularly the level of reduced glutathione, the concentration of which was depressed. The decreased concentration of GSH could either be explained by the decrease in its synthesis or by an increase in the rate of the peroxidation processes. Consistent with the latter explanation is the increase in the concentration of oxidized glutathione also found. However, in spite of these changes no disruption of cellular stability occurred, as indicated by the tests on the membranes (permeability, concentration of oxidized glutathione upon introduction of tertbutylhydroperoxide, rate of hemolysis under mechanical stress). The lack of significant activation of oxidizing processes in the erythrocytes is further confirmed by the tests of lipid peroxidation. On the first day postflight there was a drop in concentration of hydroperoxides and secondary products of lipid peroxidation. Concomitantly, there was a decrease in the concentration of polyunsaturated fatty acids. Seven days postflight there was a marked increase in the level of polyunsaturated acids, resulting in an increase in the rate of lipid peroxidation. At the

same time there was an increase in the level of hydroperoxides and of secondary products of peroxidation. The authors interpret these changes as adaptative and not pathological in nature.

Tables:

Table 1: Parameters of erythrocyte metabolism pre- and postflight

Cosmo- naut	V _{gluc} , umoles per 1 g Hb per hr			V _{lact} , umoles per 1 g Hb per hr				
	Pre- Flight	Day Post- Flight		Pre- Flight	Day Postflight			
		1	7		1	7		
						PS	plasma	PS
1	4.30	4.36	3.83	8.61	6.30	7.33	7.90	7.25
2	3.20	2.49	3.05	8.88	6.45	5.40	6.42	5.90

Cosmo- naut	Concentration 2,3-DPG umole per 1 g Hb			Activity of LDH, umoles NAD•H ₂ per 1g Hb		
	Pre- flight	Day Post- flight		Preflight	Day Postflight	
		1	7		1	7
1	13.40	16.22	--	25.82	31.03	--
2	14.22	16.12	13.86	25.57	30.63	20.80

Cosmo- naut	Concentration of ATP, umoles per 1 g Hb*					
	Preflight		Day Postflight			
	Pre-incub.	Incub.	1	7		
				Pre-incub.	Incub.	Pre-incub.
1	4.90	5.06	3.25	5.30	4.92	4.50
2	5.89	5.45	3.08	4.73	4.80	5.22

* incubated in physiological saline solution.

Table 2. Characteristics of redox processes in human erythrocytes pre- and post- flight

Cosmo- naut	G-6-P, umoles per 1g Hb					Activity of G-6-PD, umoles NADP•H ₂ 1 g Hb			
	Pre-flight		Day Postflight			Pre-flight		Day Postflight	
			1	7				1	7
	PS	plasma	PS	plasma	PS				
1	191	117	130	144	97	4.12	5.19	--	
2	117	44	99	123	138	3.39	5.95	3.13	

Cosmonaut	GSH umoles per 1 g Hb					GSSG M per 1g Hb per hr					
	Pre-flight		Day Postflight			Pre-flight		Day Postflight			
			1					1			
			7					7			
	PS	plasma	PS	plasma	PS	Pre-inc.	plasma	PS	Pre-inc.	plasma	PS
1	6.91	5.48	6.10	20	10	27	60	3	45	120	
2	9.62	8.70	6.69	26	33	28	42	0	52	102	

Table 3. Functional state of the erythrocyte membrane before and after flight

Cosmo- naut	Rate of K ⁺ permeation, umoles per 1 l erythrocytes per hr					Concentration of GSSG, umoles per 1 l erythrocytes on introduction of TBGP			
	Pre-flight		Day Postflight			Pre-flight		Day Postflight	
			1	7				1	7
	PS	plasma	PS	plasma	PS	flight			
1	2.0	1.2	1.5	0.7	1.2	300	270	350	
2	1.2	0.7	1.1	1.1	1.2	350	410	450	

Cosmonaut	Rate of hemolysis, % in 1 min in response to mechanical stress		
	Preflight	Day Postflight	
		1	7
1	1.2	1.4	2.6
2	1.2	0.9	1.8

Table 4: Percentage of fatty acids of total lipids and the state of lipid peroxidation in human erythrocyte membranes pre- and postflight

Parameter	Norm	Cosmonaut 1			Cosmonaut 2		
		Pre-flight	Postflight Day 1	Day 7	Pre-flight	Postflight Day 1	Day 7
Fatty acids (rel. %)							
myristic (14:0)	1.2±0.1	--	1.6	0.9	--	0.8	0.7
palmitic (16:0)	23.8±0.4	--	27.3	19.6	--	30.5	23.7
palmitoleic(16:1)	3.9±0.3	--	4.9	2.4	--	4.9	5.2
hexadecadenic(16:2)	1.6±0.2	--	2.9	2.0	--	1.7	1.9
stearic(18:0)	20.7±0.7	--	31.4	25.3	--	29.8	21.3
oleic(18:1)	23.5±0.7	--	27.7	26.1	--	27.2	22.8
linoleic(18:2)	10.5±0.4	--	1.9*	7.6	--	2.4*	7.3
linolenic(18:3)	1.9±0.3	--	1.9	0.8	--	2.4	2.8
eicosatrenic(20:3)	3.8±0.3	--	--	3.4	--	--	5.1
arachidonic(20:4)	10.3±1.0	--	--	11.4	--	--	6.8
Products of lipid peroxidation, nA per 1 mg lipid							
hydroperoxides	21.4±0.4	46.87	20.59	--	24.1	22.7	27.55
end products	48.6±4.6	131.70	48.9	--	57.6	42.61	80.54

*[sic] may be an error in the original

P157(12/85)* Kirichenko LL, Smirnov VV, Yevdokimova AG.

Microcirculation and cellular hemostasis in men with borderline arterial hypertension exposed to "dry" immersion in thermally neutral water. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 35-38. [10 references; 3 in English] Affiliation: Not available

Hematology, Hemostasis Cellular
Humans, Male, Patients, Hypertension
Immersion

Abstract: Eighteen men, aged 45-55, with borderline arterial hypertension were the experimental subjects for this study. Eight healthy men were used as controls. The experimental treatment consisted of 7 days of "dry" immersion, (i.e., immersion while wrapped in waterproof sheets) in thermally neutral water. Cellular homeostasis was measured before immersion, on days 3 and 7 of immersion and 48 hours after completion of the treatment. Five of the experimental subjects were tested again 5 days after the end of the immersion period. Blood was taken from the veins of the arm in the morning. Coagulation induced by ADP (adenosine 5'-diphosphate) and epinephrine solutions was studied. Microcirculation was examined biomicroscopically in the bulbar conjunctiva. Blood viscosity and lipid metabolism were measured in six of the experimental subjects. Before immersion, quantity of platelets and coagulation index values for the hypertension patients did not differ from those of the control group. On day 3 of immersion there was a tendency for the quantity of platelets, and rate and duration of coagulation induced by ADP and epinephrine to increase. These effects were even more pronounced after 7 days of immersion. Changes were analogous for the experimental and control groups. Forty-eight hours after the immersion period, all indices of cellular homeostasis had returned to normal for healthy subjects. However, in the hypertensive subjects, platelet coagulation did not return to normal until 5 days later. Biomicroscopic examination prior to immersion revealed signs of insufficient capillarization in the hypertensive subjects. These signs grew more pronounced after immersion. In a subgroup of the hypertensive subjects, blood viscosity and overall lipid concentration in the blood tended to increase and then decrease during immersion. The authors interpret this study as revealing the presence of a tendency toward hypercoagulation in borderline hypertensives. In addition, adaptive processes related to plasma and cellular homeostasis tended to be less flexible in these patients.

Table Titles: Table 1: Changes in quantity of platelets, platelet coagulation induced by ADP and epinephrine, non-esterified fatty acids and blood viscosity in individuals with borderline arterial hypertension undergoing immersion

Table 2: Changes in quantity of platelets, and platelet coagulation induced by ADP and epinephrine in healthy individuals undergoing immersion

MONOGRAPH

M51(12/85) Moiseyeva OI. Fiziologicheskiye mekhanizmy regulyatsii erythropoiesis [Physiological mechanisms for regulating erythropoiesis]. Leningrad: Nauka; 1985. [183 pp.; 11 Tables; 18 Figures; 11 diagrams]

Affiliation: I.P. Pavlov Institute of Physiology, USSR Academy of Sciences.

Key Words: Hematology, Erythropoiesis, Hypoxia

Annotation: This monograph is devoted to the study of the principal mechanisms underlying the regulation of erythropoiesis. The participation of erythrocytes in altering their own rate of formation is analyzed and information concerning the effects of neurohumoral factors and intercellular interactions on the various erythron cells as they move from one stage to the next is organized and summarized. Detailed consideration is given to the significance of functional interactions among the systems participating in oxygen transport and also to the questions of oxygen supply to the hemopoietic organs and the production of erythropoietin in the context of various functional states of erythropoiesis. The authors discuss regulation of erythropoiesis in animals and humans when the number of erythrocytes in the blood (anemia, polycythemia) and partial oxygen pressure in the environment (hypoxia, hyperoxia) is abnormal, but physiological mechanisms are still functioning.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Chapter 1. Erythropoiesis in humans and higher animals (5)

Maturation and metabolism of cells of the erythrocyte series (14)

The effect of erythropoietin on erythropoiesis (25)

Renal and extrarenal formation of erythropoietin (34)

Chapter 2. Oxygen transport by erythrocytes (42)

Erythrocyte metabolism (45)

Interaction of hemoglobin and ligands (51)

The formation of 2,3-diphosphoglycerate in the erythrocytes and its interaction with hemoglobin (58)

Chapter 3. Regulation of erythropoiesis in anemia and polycythemia (66)

Post-hemorrhage anemia (71)

Phenylhydrazine anemia (79)

Polycythemia (88)

Chapter 4. The effect of different oxygen partial pressures on erythropoiesis (99)

Hyperoxia (103)

Acute hypoxia (115)

Chronic hypoxia (125)

Conclusion (136)

Abbreviations (142)

References (143)

HISTOLOGY

(SEE ALSO: CARDIOVASCULAR AND RESPIRATORY SYSTEMS: P159)

PAPERS

P144(12/85) Shvalev VN, Kargina-Terent'yeva RA, Mar'yan KL, Pavlovich YeR. Changes in the medulla of the adrenal glands in rats subjected to immobilization stress. *Arkhiv Anatomii, Gistologii i Embriologii*. 89(8): 97-103; 1985. [13 references; 7 in English] Affiliation: Laboratory of Neurohistology and Histological Chemistry. All-Union Cardiography Center, USSR Academy of Medicine, Moscow.

Histology, Adrenal Histology; Endocrinology

Rats

Immobilization Stress

Abstract: Twelve male August rats, aged 6-8 months served as subjects. The experimental groups were immobilized for 30 hours in a specially designed cage. The adrenal glands of control animals and animals sacrificed immediately or 24 hours after immobilization were removed and examined. Adrenal tissues were examined using Wood's procedures for staining, histofluorescent analysis of cryostatic cross sections, and with an electron microscope. In the control rats, histofluorescent analysis of the adrenal medulla revealed characteristic islands of highly luminescent chromaffin cells containing catecholamines. In the immobilized rats, a number of previously unreported club-shaped cytoplasmic growths were discovered. In addition, a large amount of secretory material existed in the dilated sinusoid capillaries. Few islands of highly luminescent cells were noted and the intensity of the luminescence observed in the medulla itself was depressed. In the control rats, the cells containing epinephrine and norepinephrine were at different stages of the secretory cycle, indicating asynchronic activity. In contrast, the chromaffin cells in immobilized rats were predominantly in the secretion stage, indicating synchronization. Other histological consequences of this synchrony were observed. These results are described as adaptive compensatory reactions which help the animals survive stress. By the time 24 hours had elapsed since the termination of immobilization, asynchrony had been restored, demonstrating the flexibility of the adaptive reaction.

Figure titles: Figure 1. Catecholamines in chromaffin cells of the adrenal medulla in control rats and rat immobilized for 30 hours

Figure 2. Adrenal medulla of a control rat and a rat immobilized for 30 hours

Figure 3. Ultrastructure of chromaffin cells in the adrenal medulla of a control rat (August strain)

Figure 4. Ultrastructure of chromaffin cells in the adrenal medulla of rats immediately and 24 hours after 30-hours of immobilization

P172(12/85)* Furdud FI, Khaydarliu SKh, Mamalyga LM. Combined effects of stressors on the structure of spinal reflex arcs. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 92-95. [16 references; 3 in English] Affiliation: Not available

Histology, Spinal Cord, RNA, Proteins; Also Neurophysiology

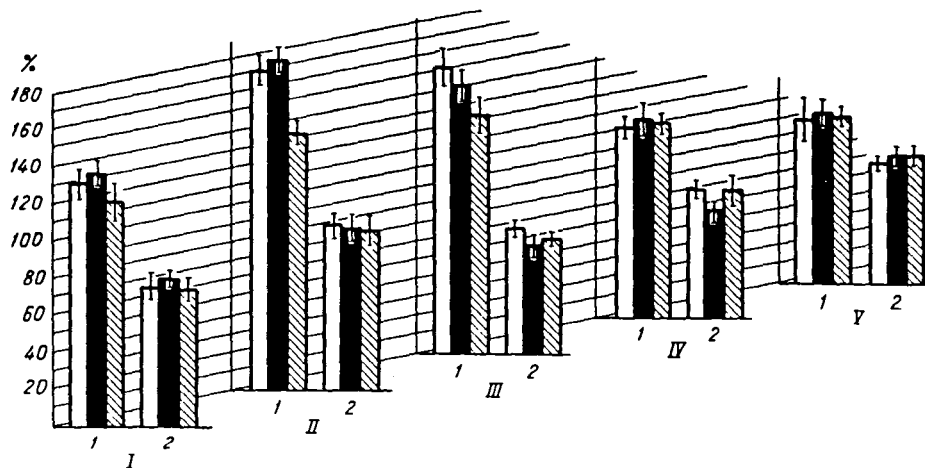
Rats

Hypokinesia, Immobilization Stress, Hypoxia

Abstract: This study investigated the combined effects of hypokinesia and hypoxia on the morphological and histochemical changes in the cellular structures of cerebrospinal ganglia and motor neuron ventrolateral nuclei of the spinal cord. One group of male Wistar rats was kept in motion restricting cages (hypokinesia group), with some rats further immobilized by restraint for 14 hours. Both the immobilization and the hypokinesia treatments were studied separately and in combination with hypoxia (one hour at altitude equivalent of 8200 m). An additional group was subjected to hypoxia alone and an untreated control group was used. There were six animals in each of the five groups. After the experiment, the animals were sacrificed and the lumbar and cervical enlargements of the spinal cord were removed for study. Histochemical analyses for RNA, total and primary proteins were performed, as were morphological measurements. The immobilization treatment alone led to an increase in the amount of cytoplasm of motor neurons of the ventrolateral nucleus in the lumbar region, while hypokinesia did not produce statistically significant effects on these indicators. In the cervical region, both immobilization and hypokinesia were associated with a significant decrease in cytoplasm in the ventrolateral nuclei. In the cervical region, the introduction of hypoxia increased the effects of immobilization on amount of cytoplasm. Examination of the cerebrospinal ganglia showed that both immobilization and immobilization combined with hypoxia increased cytoplasm in the lumbar region, but caused no effect in the cervical region. Hypokinesia, led to a decrease in cytoplasm in the cervical region. Hypoxia alone led to a cytoplasm increase in this region and the combination of the two factors cancelled each other out. No significant morphometric effects were found in the lumbar region for hypokinesia alone or hypokinesia combined with hypoxia. The most pronounced effects of the experimental treatments were observed with RNA and protein content in the motor neuron ventrolateral nuclei. In the lumbar region, immobilization led to large increases in RNA and proteins; the addition of hypoxia neither enhanced or detracted from this effect. Hypokinesia had no statistically significant effects on the amount of RNA, and total and primary proteins in motor neurons in the lumbar region. In the cervical region, hypokinesia alone, but not immobilization alone produced significant decreases in the amount of RNA and proteins. Hypoxia alone and the combination of hypoxia and both immobilization and hypokinesia also resulted in significant decreases. The treatments had no effects on RNA and protein concentration in the cerebrospinal ganglia.

Table and Figure Titles: Table: Amount of cytoplasm in neurons of various regions of the spine of control and experimental animals

Figure: Concentration of RNA (white bars), total (black bars) and primary (cross-hatched bars) proteins in the motor neurons of the ventrolateral nucleus in the lumbar (1) and cervical (2) regions of the spinal cord after exposure to hypoxia (I), immobilization (II), immobilization combined with hypoxia (III), hypokinesia (IV) and hypokinesia combined with hypoxia (V)



HUMAN PERFORMANCE

(SEE ALSO: BIOLOGICAL RHYTHMS: M49; CARDIOVASCULAR AND RESPIRATORY SYSTEMS: M39; PERCEPTION: M35)

MONOGRAPH

M38(12/85) Medvedev VI, editor. Fiziologicheskiye printsipy razrabotki rezhimov truda i otdykha [Physiological principles underlying scheduling of work and rest periods]. Leningrad: Nauka; 1984. [140 pages; 18 tables; 5 figures; 129 references; 15 in English]

Affiliation: Scientific Council on Applied Physiological Problems, I.M. Sechenov, Institute of Evolutionary Physiology and Biochemistry, USSR Academy of Sciences.

Key Words: Human Performance, Work Schedules, Rest Periods

Annotation: This group monograph is devoted to theoretical problems related to the rational scheduling of work and rest periods. Work capacity is discussed as a very valuable holistic measure of human functional status for use in the development of standardized work and rest schedules in various sectors of the economy. Various mathematical models for measuring the difficulty and stress associated with job performance are analyzed. A procedure for developing standardized schedules of work and rest periods is proposed. Questions related to shift work and shift work schedules for jobs involving continuous manufacturing processes are considered. One section is devoted to the study of rest as a component of research on work physiology, and another to a description of how the effectiveness of various work schedules can be evaluated.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)
Introduction (V.I. Medvedev) (3)

Chapter 1. Modeling of work schedules (A.L. Reshetyuk) (7)

Chapter 2. Principles and methods for developing standardized schedules for work and rest periods within a shift (B. N. Petukhov, N.S. Udarova) (40)

Chapter 3. Shift schedules for work involving continuous manufacturing processes (V.S. Aver'yanov, O.V. Vinogradova, G.A. Sorokin) (59)

Chapter 4. Nonstandard work and rest schedules in industry (I.S. Kandror) (69)

Chapter 5. Schedules of work and rest periods for workers in the transportation industry (I.S. Kandror) (113)

Chapter 6. Efficiency of rational work and rest period schedules (A.M. Veynberg, Yu. E. Briyedis, A.Zh. Yurevits, L.G. Tumasova) (131)

Appendix. Methodological instructions for researching the physiological bases of rational work and rest schedules. (I.S. Kandror, D.M. Demina) (131)

IMMUNOLOGY

MONOGRAPH

M40(12/85) Shubik VM, Levin MYA. Immunitet i zdorov'ye sportsmenov [Immunity and health of athletes]. Moscow: Fizkultura i sport; 1985. [175 pages; 32 tables; 18 figures; 140 references; 60 in English]

Affiliation: Not available

Key Words: Immunology; Immunological Competence, Physical Exertion, Athletes

Annotation: In this book, V.M. Shubik, Doctor of Medical Sciences, and M.Ya Levin, Candidate in Medical Sciences, summarize the results of many years of research on immunological competence in athletes of various sexes, ages, skill levels, and sports. They demonstrate that immunological competence varies as a function of the amount and intensity of physical exertion, and that it decreases in response to excessive exertion, especially in young athletes and women. The relationship between immunological competence in athletes and their susceptibility to disease is discussed. Approaches to preventing disease and restoring immunological competence are outlined. The book is intended for practioners of sports medicine and trainers.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Introduction (3)

1. Local Immunity (7)

- 1.1 Saliva lysozyme (11)
- 1.2 Saliva immunoglobulins (17)
- 1.3 Barrier characteristics of the skin (18)

2. Parameters of nonspecific protection (30)

- 2.1 Humoral factors in nonspecific protection (30)
- 2.2 Cellular factors in nonspecific protection (46)
- 2.3 Interferon and lymphokines (58)

3. T- and B-systems of immunity (61)

- 3.1 T-system of immunity (63)
- 3.2 B-system of immunity (74)
- 3.3 Autoantibodies (87)

4. The health of athletes (106)

- 4.1 Longevity (aging) (109)
- 4.2 Reproductive functioning (113)
- 4.3 Work capacity (117)
- 4.4. Susceptibility to disease (118)

5. On preventing immunological disorders in athletes (143)

Conclusion (156)

References (170)

LIFE SUPPORT SYSTEMS: SEE HABITABILITY AND ENVIRONMENT EFFECTS: P171

MATHEMATICAL MODELING
(SEE ALSO: BIOSPHERICS: M53, M52)

MONOGRAPHS

M34(12/85) Gel'fand IM, scientific editor. Voprosy kibernetiki: Zadachi meditsinskoy diagnostiki i prognozirovaniya s tochki zreniya matematika [Issues in cybernetics: The problems of medical diagnosis and prognosis from the mathematician's point of view]. Moscow: Scientific Committee on the Interdisciplinary Problem of Cybernetics, USSR Academy of Sciences; 1985. [ca. 200 pages]

Affiliation: Scientific Committee on the Interdisciplinary Problem Cybernetics, USSR Academy of Sciences

Key Words: Health and Medical Treatment, Diagnosis, Prognosis, Cardiovascular Disease; Mathematical Modeling, Computer Modeling

Annotation: This collection contains papers by a group of mathematicians and physicians on diagnosis and prognosis in various areas of medicine. The papers in this collection cite concrete medical problems to illustrate the general principles underlying the collaboration of mathematicians and physicians in the effort to define these problems and obtain reliable well-organized data. Methods for structuring medical data bases utilizing physicians' expertise are demonstrated. Techniques for developing questionnaire formats are described in detail.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Gel'fand IM, Rozenfel'd BI, Shifrin MA. A data structure for use in solving problems in medical diagnosis and prognosis (5)

Gel'fand IM, Guberman ShA, Gindikin SG, et al. Classification and prognosis problems taken from various areas of medicine (65)

Alekseyevskaya MA, Nedostup AV. Diagnostic games in medical problem solving (illustrated with the example of predicting duration of sinus rhythm maintenance after elimination of atrial fibrillation) (128)

Gel'shteyn GG, Zingerman LS, Lukashevich IP, Shifrin MA. EKG classification in patients with chronic cardiac ischemia and severe coronary artery disease (139)

Guberman ShA, Gel'fand IM, Dzyuba GI, Kuznetsov LV. Holistic approach to identifying objects in automated analysis of chest X-rays (148)

Chernyakevich SA, Cherednik IV. Formal differential description of stomach and duodenum motility (172)

M41(12/85) Baydosov VA, Fefelova VA. Matematicheskoye modelirovaniye protsessov v meditsinskikh i biologicheskikh sistemakh: [Sb. statey] [Mathematical modeling of processes in medical and biological systems: [Coll. of papers]. Sverdlovsk: 1982. [76 pages; 7 tables; 22 figures; 53 references; 8 in English]

Affiliation: Ural Scientific Center, USSR Academy of Sciences.

Key Words: Mathematical Modeling, Biological and Physiological Systems; Health and Medical Treatment, Cardiovascular Systems, Thyroid, Cytology, Cell Development; Perception, Pattern Recognition

Annotation: This collection addresses issues relevant to mathematical modeling of processes in living systems, control of these processes, and their classification and diagnosis. Techniques and concepts derived from differential equations, mathematical programming and pattern recognition, and the theory of algorithms and random processes are used to construct these models. Papers are devoted to modeling and diagnosis of disease of the thyroid gland, predicting the course of a delivery, automated diagnosis in cardiology, the effect of dispersion of heart rhythm on contractility of the myocardia, and control over elimination of toxic metals from the body. A portion of the papers is devoted to modeling population dynamics.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Mazurov VID. On ill structured tasks in complex systems analysis (3)

Baydosov VA, Tarasenko VD, et al. Simplified models of the kinetics of radioactive iodine in the human body under normal conditions and in thyrotoxicosis (9)

Mamin VV, Smirnov AI. Radionuclide diagnosis of hypothyroid states using mathematical methods of image recognition,

Chashchin GV, Kazantsev VS. Use of pattern recognition methods in predicting the outcome of delivery for the infant (25)

Azanov VF, Zadorin YuA, Markhasina IP. Structure of a system for the automated analysis of electrocardiograms. (36)

Azanov VF, Lavuta PG, Markhasina IP. Algorithms for analyzing electrocardiograms. (42)

Izakov VYa, Protsenko YuL. Studying the contractility of the myocardium in response to simulation of stochastic variations in heart rate (48)

Baydosov VA, Voroshilin SYe, Pogatkin AN. Control over the elimination of a toxic metal from the body (56)

Mazurov VID, Smirnov AI, et al. A mathematical model of the genetic structure of a population. (66)

Kislyak VM, Mamina VP. Mathematical modeling of the process of cell development under extreme conditions. (72)

METABOLISM

PAPERS

P143(12/85) Bol'shakova TD, Meshcheryakova SA, Tyabenkova VF, Romanova NI, Levin YaI, Dallakyan IG. The effect of 24 hours of sleep deprivation on metabolism of biogenic amines. *Fiziologiya Cheloveka*. 11(4): 652-656. [26 references; 15 in English] Affiliation: I.M. Sechenov Medical Institute, Moscow.

Metabolism, Biogenic Amines; Biological Rhythms
Humans, Males
Sleep, Deprivation, Short-term

Abstract: Ten healthy men in their mid-twenties participated in this experiment on the effects of a relatively short period of sleep deprivation. Concentration of a number of biogenic amines in subjects' blood and/or urine was determined before the experiment (baseline condition), after 24 hours of sleep deprivation, and after a night's sleep subsequent to the deprivation. Substances tested for included: histidine; histamine; tryptophan; 5-hydroxytryptophan; serotonin; 5-hydroxyindoleacetic acid; free, conjugated and total epinephrine, norepinephrine and dopamine; 3,4-dioxyphenylalanine, metanephrine and normetanephrine; vanillylmandelic acid; and homovanillic acid. All indicators of catecholamine metabolism with the exception of metanephrine increased significantly after 24-hours of sleep deprivation. A compound indicator summing all individual indicators of sympatheto-adrenal system activity increased by 199%. All indicators of serotonin and histamine metabolism, with the exception of hydroxytryptophan, increased in the urine, and tryptophan and serotonin decreased in the blood. After a single night's sleep following the sleep deprivation period, most of the indicators had returned to the baseline level. Exceptions to this were normetanephrine and vanillylmandelic acid. Metanephrine excretion was lower than the baseline level and serotonin in the blood continued to decrease. The authors conclude that: 1) sleep deprivation lasting 24-36 hours represents a strain on the biogenic amine system which is manifested in an increase of renal excretion of almost all the substances examined, demonstrating an increase in secretory activity; 2) a positive relationship exists between level of activity of the subjects and the amount of biogenic amine secreted; 3) some indicators (particularly, serotonin) of biogenic amine metabolism did not recover after a normal night's sleep, demonstrating that relatively short periods of sleep deprivation produces some residual effects.

Table Titles: Table 1: Changes in indicators of catecholamine metabolism after a sleepless night and a subsequent night's sleep

Table 2: Changes in renal excretion of serotonin and histamine after a sleepless night and a subsequent night's sleep

Table 3: Changes in levels of serotonin and histamine in the blood after a sleepless night and a subsequent night's sleep

P170(12/85)* Vlasova TF, Miroshnikova YeB, Belakovskiy MS, Kochetkova AN, Sergeyev IN. The effect of 24,25-dihydroxycholecalciferol on amino acid metabolism in rats subjected to hypokinesia. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 88-89. [9 references; 3 in English] Affiliation: Not available.

Metabolism, Amino Acid

Rats

Hypokinesia; Nutrition, Vitamins, 24,25-dihydroxycholecalciferol

Abstract: This study investigated the possibility of normalizing amino acid metabolism disrupted by hypokinesia by adding an active metabolite of vitamin D₃ -- 24,25-dihydroxycholecalciferol. Four groups of rats (N not specified) undergoing 30 days of hypokinesia were given (apparently by injection) a daily dose of 0.25 mg/kg, equivalent to five times the required dose for rats. Rats in group 1 consumed a diet in which the calcium to phosphorus ratio was 1:0.5; this ratio was 1:1, 1:2 and 1:4 for rats in groups 2, 3 and 4, respectively. Control counterparts (i.e., animals not given D₃ metabolite but otherwise treated identically) were used for each group. Concentration of 17 amino acids in blood serum was determined. Animals on diets without the supplementary vitamin D₃ reacted to hypokinesia with a decrease in the total amino acid pool in blood serum. Adding 24,25-dihydroxycholecalciferol to the diet increased amino acid level only for animals in group 1 (1:0.5 calcium-phosphorous ratio). This dietary supplement actually decreased amino acid level for group 2 rats (1:1) and had no significant effect on the other two groups.

Table Title: Content of free amino acids in blood serum of rats undergoing hypokinesia with diets containing varying ratios of calcium and phosphorous with and without administration of 24,25(OH)₂D₃

MICROBIOLOGY
(SEE ALSO: EXOBIOLOGY P177; M55)

PAPER

P182(12/85)Vaulina EN, Ankeyeva ID, Slashcheva NK. Viability and mutability of Chlorella cells. In Dubinin NP, editor, Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [In Dubinin, editor. Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 43-45. (See Issue 1 of Digest, pp. 66-69.)

Microbiology, Viability, Mutability; Also Cytology
Chlorella
Space Flight, Salyut-Soyuz, Soyuz-22

Abstract: Early experiments on the effects of space flight on Chlorella had contradictory results, attributable to the conditions under which the organisms were held pre- and postflight. The series of experiments described here exercised greater control over pre- and postflight conditions and compared the sensitivity of active cultures to space flight factors to that of inactive cultures. Results obtained from these experiments, performed on the "Soyuz-22" and "Soyuz-Salyut" complexes, were juxtaposed to earlier results. In the present experiments the inactive culture was exposed in ampoules containing a mineral medium, while the active culture was held in a fully organic medium in darkness. Both cultures were exposed to space flight on the "Soyuz-Salyut" complex, the active culture for 7 to 18 days and the inactive culture for 8 days. Only the inactive culture was housed on the "Soyuz-22." Both cultures were placed in a mineral medium postflight and cultivated under continuous illumination at 30°. Survival rate, frequency of mutants, and average number of autospores into which the parent colony divided in the first sporulation after inoculation were measured. Deviations in the number of autospores from the norm (4, 8 and 16), and the presence of cells differing in size (frequently nonviable) were considered abnormalities. The inactive culture showed reliable differences from the norm only after 18 days of flight and only in the number of aberrant microcolonies. Similarly, the active experimental culture differed significantly from the norm only in one of the two 18-day exposure conditions and only in a single parameter -- reduced survival rate. Differences among experiments are attributed to unidentified random factors. The authors conclude that space flights of up to 18 days have only slight effects on the viability and mutability of Chlorella cultures, in both active and inactive forms.

Table 9: Effects of space flight factors on inactive cultures of Chlorella of strain LARG-1

Spacecraft (exposure duration)	Condition	Survival rate, %	Mean number of auto- spores	Microcolonies with abnormali- ties, %	Mutant Frequency, %
"Soyuz-22" (8 days)	Control	92.85	9.03	1.81	0.81
	Experimental	95.22	8.57	3.75	1.36
"Salyut-6"- "Soyuz" (8 days)	Control	94.60	8.08	0.67	0.35
	Experimental	96.18	8.26	1.51	0.47
"Salyut-6"- Control:					
"Soyuz" (18 days)	Laboratory	95.39	7.84	7.65	0.67
	Transport	85.86	7.71	8.52	1.21
	Experimental	96.39	7.93	13.35	1.27

Table 10: Effects of space flight factors on active cultures of Chlorella of strain LARG-1

Spacecraft (exposure duration)	Condition	Survival rate, %	Mean number of auto- spores	Microcolonies with abnormali- ties, %	Mutant Frequency, %
"Salyut-5" - "Soyuz" (8 days)	Control	93.35	9.00	13.03	1.17
	Experimental	90.00	9.01	9.75	1.82
"Salyut-6"- "Soyuz" (7 days)	Control	95.76	8.26	1.16	0.22
	Experimental	97.66	8.29	1.73	0.30
"Salyut-6" "Soyuz" (10 days)	Control	93.92	8.16	0.84	2.69
	Experimental	92.27	8.01	1.49	2.74
"Salyut-6" "Soyuz" (18 days)	Control	97.72	8.03	2.44	2.52
	Experimental	92.95	8.04	4.93	2.97
"Salyut-6" "Soyuz" (18 days)	Control	97.68	7.92	3.84	1.85
	Experimental	98.85	7.95	8.25	1.65

MUSCULOSKELETAL SYSTEM
(SEE ALSO: CARDIOVASCULAR AND RESPIRATORY SYSTEMS: P162;
NEUROPHYSIOLOGY: P160)

PAPERS

P154(12/85)* Zatsiorskiy VM, Sirota MG, Prilutskii BI, Raytsin LM, Seluyanov VN, Chugunova LG. Biomechanical description of body and movements of humans subjected to a 120-day period of hypokinesia with head-down tilt. *Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina*. 19(5): 23-27. [7 references; 3 in English] Affiliation: Not available

Musculoskeletal System, Muscle Atrophy, Walking
Humans, Males
Hypokinesia, Head-down tilt

Abstract: Six males, aged 31-45, weighing 68-91 kg, participated in this study. The experimental treatment consisted of a 120-day period of hypokinesia with head-down tilt (angle not specified). Several days before and 3 days and 2 weeks after the treatment, 10 parts of the body (head, shoulder, forearm, hand, thigh, shin, foot, and the upper, middle and lower portion of the torso) were measured using standard anthropometric techniques and the content of muscle, bone and fat tissue calculated. In addition, the weight and moment and radius of inertia were determined for each segment using radioisotopes and a scanning device. Three days after hypokinesia subjects were asked to walk at their own rate along a 15-meter track equipped with two tensometric platforms. Supporting reactions, mean speed, and length of stride were recorded. Two weeks after hypokinesia ended, an additional walking test was given. In this test the subject was asked to walk along the track five or six times at various speeds. External mechanical work was computed from the horizontal longitudinal and vertical projections of the vectors and rate of displacement of the overall center of gravity. Values for speed and amplitude of displacement were computed by integrating supporting reactions. Horizontal and vertical components of kinetic energy and potential energy of the center of gravity were calculated using horizontal and vertical speeds and vertical displacement of the center of gravity. These values were used to estimate the various components of external mechanical work. A coefficient of recuperation was also computed. One day after hypokinesia terminated subjects showed significant decreases in the weight of their knees and shins, and increases in weight of the shoulder and three trunk areas. Circumference of the thigh and shin decreased significantly, while that of the lower trunk increased. (Shoulder and other trunk areas increased, but not to a significant extent.) Significant increases in skin fold thickness were found in the thigh, shin and three trunk areas, while skin fold thickness in the shoulder decreased. Two weeks after hypokinesia no measurements differed significantly from their baseline levels. The authors attribute these results to muscle atrophy and compensatory replacement of muscle tissue by fat. These processes are said to occur to different extents for the different body parts affected. Both one day and two weeks after hypokinesia, the kinematic parameters of walking were found to have undergone the following

changes with respect to the norm: 1) length and duration of stride had increased, while frequency of steps and number of cycles per second had decreased; 2) mechanical energy consumed in walking had increased and recuperation of mechanical energy had decreased, (i.e., there had been a decrease in the mechanical efficiency of the walking process); 3) the rank order of amplitudes of the harmonic vertical components of the supporting reactions had altered.

Table and Figure Captions: Table 1: Changes in the weight, circumference and skin fold thickness of parts of the body after 120-day period of hypokinesia with head-down tilt

Table 2: Biomechanical parameters of normal walking and walking after hypokinesia

Figure: Relative amplitude of the harmonics of the vertical component vector of the supporting reaction

P161(12/85)* Oganov VS, Skuratova SA, Shirvinskaya MA. Contractile properties of the myofibrils of rats under long-term exposure to +2 G_x. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 53-56. [18 references; 10 in English] Affiliation: Not available

Musculoskeletal System, Myofibrils, Contractility

Rats

Artificial Gravity, Centrifugation

Abstract: Two groups of rats underwent centrifugation for 21 days at 1.1- and 2-g in the apparatus described in abstract P160 of this Digest issue. A third group of rats served as a control. After centrifugation the rats were sacrificed and muscles of the hind limbs (soleus and extensor digitorum longus) and front limbs (medial head of the triceps brachialis and brachialis) were isolated and weighed. Contractions of prepared myofibrils induced by ATP+Ca²⁺ were studied. The only statistically significant change in muscle weights was an increase in the weight of the triceps brachialis in rats exposed to 2-g. Amplitude (strength) of induced contractions was above the control level for the postural (slow) muscles of both legs, although this increase was not statistically significant in the soleus of the 1.1-g group. A tendency for the strength of the fast twitch muscles to increase was also noted. Work capacity of the anterior postural muscles increased significantly, that of the posterior postural muscles increased to a nonsignificant extent and that of the fast twitch muscles of both legs tended to decrease. Contraction latency decreased in the anterior postural muscles and in the posterior postural muscles for the 2-g group. Latency remained at approximately control level for the fast twitch muscles of both fore and hind legs. The authors note that for the postural muscles, the effect of artificial gravity is exactly opposite to that of weightlessness and thus may be used as a countermeasure in space.

Table Titles: Table 1: Weight of muscles of rats after 21 days of centrifugation

Table 2: Isometric tension and impulse of force of rat myofibrilia after 21 days of centrifugation

Table 3: Latency of isometric contractions of rat myofibrilia after 21 days of centrifugation

P163(12/85)* Tikunov BA, Kayfadzhyan MA, Oganessian SS. Change in the physicochemical properties of contractile and regulatory protein of different types of muscle during and after acceleration stress. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 60-64. [18 references; 7 in English] Affiliation: Not available

Musculoskeletal Muscles, Actomyosin

Rats

Acceleration

Abstract: Eighty male Wistar rats were subjected to 25-minute sessions of $+5G_x$ acceleration over 15 days. Forty rats were sacrificed immediately at the end of this period (Group 2) and 40 (Group 3) after a readaptation period of 30 days. A control group (Group 1) was also used. After sacrifice, the medial head of the triceps brachii, the brachialis muscles, the extensor digitorum longus, and the musculus soleus were isolated for study. Crude actomyosin was extracted and partially purified to remove regulatory proteins (tropomyosin-troponin complex). The rate of superprecipitation (measured by change in optical density per unit time), and Mg^{2+} -ATPase activity (measured by change in nonorganic phosphate per unit time) were determined for the crude and partially purified actomyosin for these four muscles of the animals in all three groups. For slow twitch muscles, acceleration increased the values of both parameters in both the crude and partially purified actomyosin. After the 30-day recovery period, values of these parameters dropped although not always to their initial values. For fast twitch muscles, exposure to acceleration was associated not with increases, but with decreases in the values of the parameters. Furthermore, the magnitude of the effect was less than that for slow twitch muscles and changes occurred only in the crude, and not in the partially purified actomyosin, suggesting that only regulatory and not contractile -- proteins were affected in fast twitch muscles. Recovery of protein after 30 days was more complete for the fast twitch muscles than for the slow twitch ones.

Table Titles: Table 1: Change in the physicochemical properties of crude actomyosin from the skeletal muscles of rats exposed to periods of acceleration and after one month of readaptation

Table 2: Change in the physicochemical properties of partially purified actomyosin from the skeletal muscles of rats exposed to periods of acceleration and after one month of readaptation

NEUROPHYSIOLOGY

(SEE ALSO: CARDIOVASCULAR AND RESPIRATORY SYSTEMS: P164; HISTOLOGY: P172; RADIOBIOLOGY: P183)

PAPERS

P141(12/85) Lapayev EV, Vorob'yev OA. Identification of vestibular asymmetry in the flight medical examination. Voenno-meditsinskiy zhurnal. 1985(8): 53-56. [7 references; none in English, but American authors cited in text]. Affiliation: Medical Corps

Neurophysiology, Vestibular Nystagmus
Humans, Pilots
Asymmetry

Abstract: This study investigated the diagnostic utility of information about vestibular asymmetry in flight medicine. Subjects were fighter pilots, students in flight school, flight school drop-outs, and healthy individuals in nonflight related professions (numbers not specified). Symmetry of nystagmic reactions were studied with specific and nonspecific stimulation of the semicircular canals in a rotation test and in a binaural, bithermal caloric irrigation test. Electronystagmometry with eyes closed was used to record horizontal nystagmus. Evaluation was based on duration of nystagmus, number of eye movements and mean (in the first 10 seconds of the rotation test and for 20 seconds during peak nystagmus produced by caloric irrigation) frequency, amplitude and rate of the slow phase. Asymmetry of vestibulo-spinal reactions was assessed using a modified stepping test; tolerance of Coriolis acceleration was also measured. Most subjects in both groups demonstrated moderate asymmetry in nystagmic and vestibulo-spinal reactions. The amount and even direction of the asymmetry varied for a given individual over time. Flight school drop-outs showed more nystagmic asymmetry than flight school students and pilots. Some pilots showed increased asymmetry, in the form of unidirectional spontaneous nystagmus, after flights. Individuals with poor vestibular tolerance tended to show nystagmus with lower frequency and higher amplitude, while highly tolerant individuals had the reverse characteristics. Tolerant subjects showed less asymmetry in amplitude than less tolerant subjects. Twelve hours of sleep deprivation increased vestibulo-spinal asymmetry. The authors conclude that more than one diagnostic indicator should be used to evaluate bilateral nystagmic asymmetry. Since asymmetry of spontaneous vestibulo-spinal and nystagmic reactions are the most sensitive indicators of the state of the vestibular system and since they are relatively easy to measure, the authors recommend their use as a rapid way to test for asymmetry of vestibular function. Unidirectional spontaneous nystagmus may indicate that a given subject has been subjected to stress beyond his tolerance.

Table and Figure Captions: Table 1: Magnitude of post-rotation nystagmus in individuals with varying resistance to motion sickness

Table 2: Magnitude of post-rotation nystagmus as a function of sequence of left and right rotations

Figure: Magnitude of bilateral asymmetry of post-rotation nystagmus.

P142(12/85) Ivanov AL, Snitko VM. Use of acupuncture in the prevention and cure of motion sickness. *Voyenno-meditsinskiy zhurnal*. 1985(8): 56-57. [12 references; none in English] Affiliation: Not available.

Neurophysiology, Motion Sickness

Human, Sailors

Health and Medical Treatment, Countermeasures, Acupuncture

Abstract: Under conditions conducive to motion sickness, electric conductivity of 12 standard pathways of acupuncture points was determined by measuring conductance at 24 points along each of them. This procedure showed that motion sickness, regardless of its form or severity, affected conductivity, particularly along the pathways of the heart, three parts of the torso,, spleen - pancreas, small intestine, and bladder. Conductivity in the three portions of the torso and small intestine decreased, while that in the other pathways increased. The authors state that on the basis of these results they were able to use electroacupuncture to cure sea sickness on long-term cruises. Note: no further details are specified.

P155(12/85)* Davydov NA, Galkina YeYu, Ushakov AS. Functional activity of the serotonin and histaminergic systems in humans subjected to long-term hypokinesia. *Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina*. 19(5): 27-30. [10 references; 2 in English] Affiliation: Not available

Neurophysiology, Histamines

Humans, Males

Hypokinesia, Head-down Tilt, Long-term

Abstract: Six healthy male volunteers, aged 25-40, were subjected to a 120-day period of hypokinesia with head-down tilt of -4.5° . Venous blood was taken before, on days 25, 56, 70, and 112 of hypokinesia, and on days 1, 7, 14 and 25 of the post-hypokinesia recovery period. All urine was collected in the baseline period, on days 4, 10, 25, 32, 52, 75, 100, 112 and 120 of hypokinesia and on days 4 and 8 post-hypokinesia. Activity of the serotonin and histaminergic systems was estimated by measuring the concentration of tryptophan, 5-hydroxytryptophan, serotonin, histamine, and histidine in the blood and urine and of 5-hydroxyindoleacetic acid in the urine. All baseline measurements were within normal limits. Coefficients were derived to reflect serotonin metabolism, histamine metabolism and the ratio between them. In the initial period of hypokinesia (days 4-10), there was an increase in renal excretion of tryptophan, and 5-hydroxytryptophan, serotonin and histamine. Serotonin metabolism rate and the serotonin/histamine ratio were still at baseline level, indicating increased elimination of serotonin and its precursors without change in the synthesis rate. The increased level of serotonin in the body was probably caused by hemodynamic shifts and/or emotional reactions to hypokinesia. After the initial period, the blood concentration and renal excretion of tryptophan gradually decreased, while concentration and excretion of serotonin, 5-hydroxytryptophan, and 5-hydroxyindoleacetic acid significantly exceeded baseline levels on days 32, 52 and 56 of hypokinesia. These changes caused the ratio of 5-hydroxytryptophan to tryptophan to increase sharply. The ratio of serotonin to 5-hydroxytryptophan increased from days 52 to 70. The ratio of 5-hydroxyindoleacetic acid to serotonin decreased, accompanied by increased excretion of the former. These data indicate an enhancement of the activity of the serotonin system, which in this study was accompanied by subjects developing neurasthenic symptoms, indications of autonomic vascular dysfunction and other disorders associated with activation of the adrenal sympathetic system. In the final period of hypokinesia, the concentration of serotonin in the blood and urine decreased and the level of 5-hydroxyindoleacetic acid increased, while the ratio of serotonin to 5-hydroxytryptophan was lower than its initial level. The authors attribute the change in the activity level of the serotonin system after 70 days of hypokinesia to the beginning of adaptation to hypokinesia and the development of a response to decreased afferent stimulation. Throughout the hypokinesia period, the concentration of histamine in the blood and urine exceeded initial values, the concentration of histidine gradually decreased and the ratio of histamine to histidine rose significantly above baseline, indicating a relative increase in histamine synthesis. The increased level of histamine is an adverse effect which must be considered when

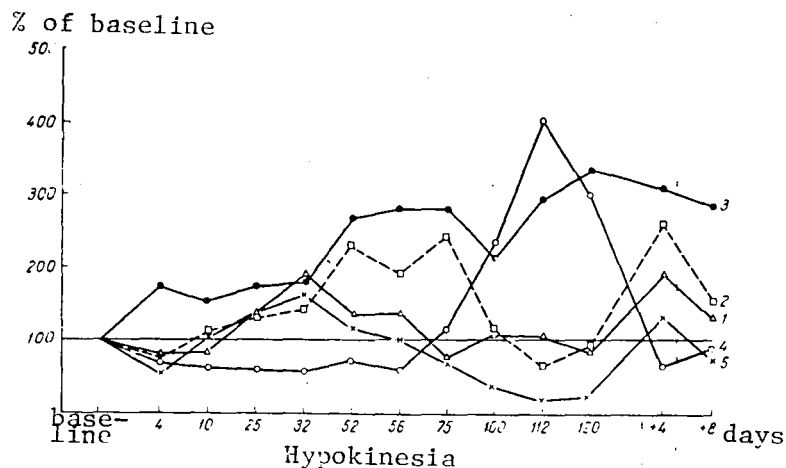
countermeasures are developed. Return to normal activity led to increases in levels of tryptophan, 5-hydroxytryptophan, serotonin, histamine and histidine in the blood and urine, and an increase in the relative activity of the metabolic process. This demonstrates the stress that hypokinesia placed on these systems by the increased demands of the cardiovascular and musculoskeletal systems. By day 25 after the termination of hypokinesia, all indicators had returned to normal.

Table and Figure Titles: Table 1: Concentration of serotonin, histamine and their precursors in the blood of subjects

Table 2: Excretion of serotonin, histamine, their precursors and metabolites in subjects

Figure: Indicators of relative activity of serotonin and histamine metabolism under hypokinesia with head-down tilt, based on urinalysis data

1 - 5-hydroxytryptophan; 2 - serotonin/5-hydroxytryptophan; 3- histamine/histidine; 4 - 5-hydroxyindoleacetic acid/serotonin; 5 - serotonin/histamine.



P160(12/85)* Shipov AA, Shvets VN, Tabakova LA, Kabitskaya OYe. Changes in the physical condition, vestibular function and skeletal system of rats undergoing long-term rotation. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 46-52. [22 references; 9 in English] Affiliation: Not available

Neurophysiology, Vestibular Nystagmus; Musculoskeletal System, Bone Growth
Rats
Artificial Gravity, Centrifugation

Abstract: Four experiments were performed, each involving rotating groups of rats in a centrifuge. Rats were housed together in cages which did not restrict movement; containers at the center of the centrifuge were exposed to 1.1-g, while those at the periphery were exposed to 2.0-g. All rats were fed a standard diet and exposed to alternating 12 hour periods of light and darkness. Centrifugation was interrupted for one hour each day. At this time, cages were cleaned and experimental variables were measured. Experiments 1-3 apparently used the same group of 30 albino rats. The first two experiments investigated the effects of 21 days of centrifugation on static and dynamic endurance respectively. Static endurance was operationally associated with the maximum time rats were able to stay on a pole [Note: procedure not further specified] and dynamic endurance with the maximum time rats were able to swim in 33-36°C water carrying a weight 20% of their body weights. Static endurance was tested before, after, and on days 4, 7 and 14 of centrifugation and dynamic endurance before, after and on days 5, 8 and 15. Experiment 3 investigated the effects of 21 days of centrifugation on the vestibular function and on balance. Vestibular function was investigated by observing the effect of angular acceleration of 30°/sec² on the nystagmic reaction. Balance was examined through observing animals on inclined planes. Nystagmus was tested before, after and on days 2, 6, and 13 of centrifugation and balance before, after, and on unspecified days during the centrifugation. Behavioral observations of the animals were also performed. Experiment 4 investigated the effects of periods of up to 30-days of centrifugation on morphometric characteristics of the skeletal system. Eight rats were sacrificed and studied before centrifugation, and 8 each on days 7, and 22 of centrifugation. On day 30 of centrifugation, 7 control rats, 7 rats from central cages and 7 from peripheral cages were sacrificed. Femur and tibia bones were measured after sacrifice; bones were then decalcified and processed histologically. Measurements were also made of cross sectional area, the cortical layer, and of the marrow channel of the diaphysis. The epiphysial layer and the spongy bone of the metaphysis were also measured.

During the first few minutes of centrifugation, animals centrifuged at both g levels increased their motor activity. Immediately afterward animals at the center (1.1-g centrifugation) moved to the outer walls of the container so that the resulting centripetal and gravitational force acted in the back - chest direction. They rarely moved from this area for the next 2-3 days. Starting at days 3-4, activity increased and the animals moved throughout the container, although, coordination was somewhat impaired. Motor activity peaked at days 7-8

and then began to drop; by day 15, activity did not differ from that of control animals and normal coordination was restored. Animals under 2-g (the peripheral group), showed no preference for location within the container during initial days. Their motor activity was lower at all points than that of the 1.1-g group. Supplementary studies with delabyrinthized animals indicated that the vestibular system was a critical factor in determining the effects of centrifugation on motor activity. For animals centrifuged at 1.1- and 2-g balance tests revealed no differences from control animals or each other. In the first week of centrifugation, animals in both groups suffered some weight loss, more pronounced for the 2-g group. Subsequently, centrifuged animals gained weight at a somewhat slower rate than control animals. Both static and dynamic endurance, measured under normal conditions, increased in animals undergoing centrifugation, reaching a maximum on day 7-8 and then returning to baseline levels. The increase was more pronounced in animals in central cages (1.1-g). The authors conclude that there is no evidence that centrifugation at 1.1 or 2-g is detrimental to physical condition or balance in rats.

Nystagmus in control animals decreased in magnitude from session to session indicating adaptation to angular acceleration. The duration and frequency of nystagmus for centrifuged animals had dropped to half baseline (and control) level on the second day of centrifugation, but did not drop significantly subsequently. This suggests that the centrifugation itself has an adaptive effect with regard to angular acceleration. After centrifugation, nystagmic reactivity in experimental animals gradually increased, but remained considerably below control and baseline values 22 days after centrifugation. Thus no evidence could be found that centrifugation impairs vestibular functioning.

By day 18-19 of centrifugation, both groups of experimental animals showed only slight decreases in longitudinal growth of bone relative to control animals. Lateral bone growth was depressed in the initial period of centrifugation but subsequently normalized. On the basis of other results, the authors attribute this to a stress reaction. Animals undergoing 2-g acceleration showed a decrease in the area of the cortical layer relative to control animals only at day 7. Subsequently this parameter returned to normal. No effects of centrifugation were found in the marrow cavity. The authors emphasize that these results indicate that there is no evidence for pathological effects of short-term centrifugation on skeletal bone.

Tables and Figure Titles: Table: Metaphysial measurements in the tibial bones of rats as a function of centrifugation duration

Figure 1

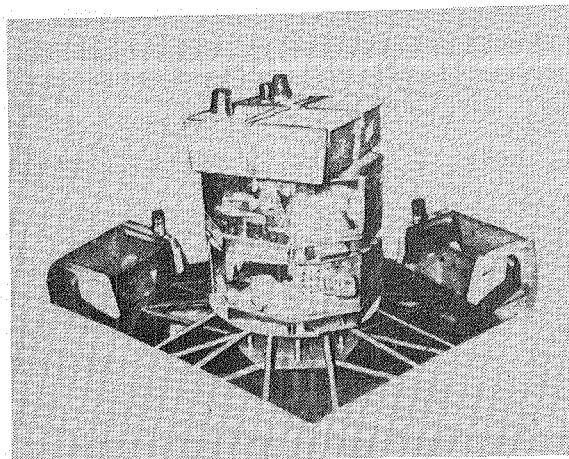


Figure 1: Centrifuge for long-term centrifugation of animals. (Two of the six peripheral containers and three central containers can be seen.)

Figure 2: Body weight, static and dynamic endurance of rats undergoing during and after 21 days of centrifugation

Figure 3

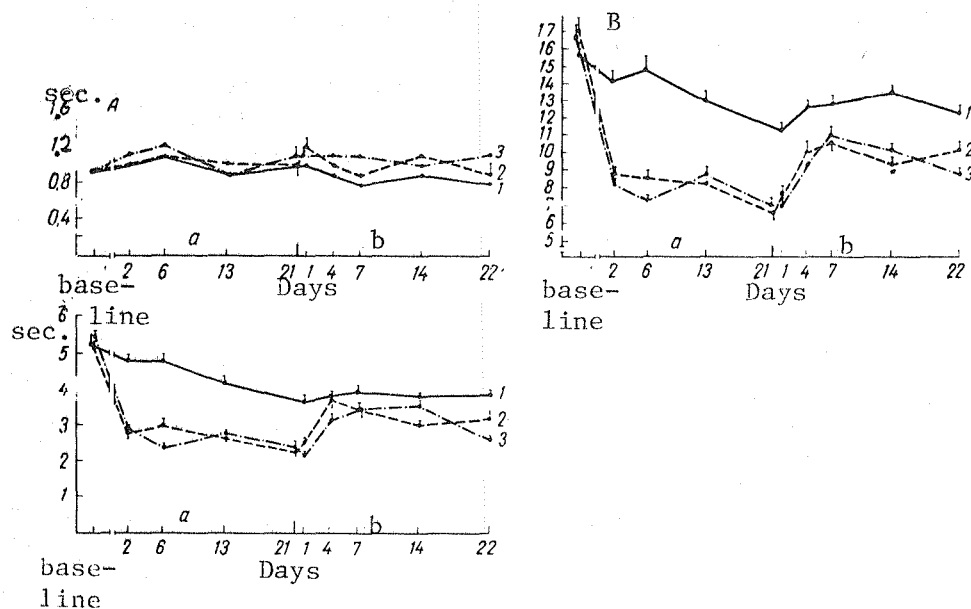


Figure 3. Latent period (A, in seconds), number of eye movements (B), and duration (C, in seconds) of nystagmus in rats during (a) and after (b) 21 days of centrifugation

Abscissa: Day of Experiment; angular acceleration, $30^\circ/\text{sec}$

Figure 4: Cross sectional area (A), cortical layer(B), and marrow cavity (C) of the tibia (I) and humerus (II) of rats undergoing 30 days of centrifugation. Abscissa: Day of rotation: Ordinate: area (in standardized units)

P165(12/85)* Stolbkov YuK. Dependence of nystagmus on the function of the utricle. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 68-72. [18 references; 3 in English] Affiliation: Not available

Neurophysiology, Nystagmus, Cervical; Utricular Nerves
Birds, Doves
Acceleration, Angular

Abstract: Twelve doves (*Columba livia*) served as subjects in this experiment. The first series of nystagmus tests were made on intact doves; the second after unilateral and the third after bilateral severing of the utricular nerve. In the tests, the animals were restrained and rotated in the dark in a trapezoidal pattern involving 10 degrees/sec² of positive rotation, 2 minutes of rotation at an angular velocity of 166.6 degrees/sec and negative acceleration at 10 degrees/sec². A series involved 12 tests, 6 to the left and 6 to the right. Cervical nystagmus was recorded during the tests by measuring muscle potentials, latency period, reaction duration and number of movements calculated for left and right nystagmus for each bird. Unilateral severance of the utricular nerves led to pronounced inhibition (increased latency, decreased duration, decreased movement frequency) of nystagmic reactions directed toward the affected labyrinth. Bilateral severance led to symmetrical inhibition of nystagmus, which was total in 50% of the birds. Results are interpreted as indicating that the utricular nerves play an active role in regulating horizontal nystagmus in response to angular acceleration in doves.

Table Title: Mean values of parameters of cervical nystagmus in doves before and after severance of the utricular nerves

P167(12/85)* Levashov MM. Role of vestibular recruitment and directional predominance in nystagmus in diagnostic examinations. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 78-81. [1 reference; none in English] Affiliation: Not available

Nystagmus, Directional Predominance
Review/Theoretical Article, Patients
Diagnosis

Abstract: The term vestibular recruitment refers to a situation where the difference between magnitudes of nystagmic reactions to a moderate and to a strong nystagmus-inducing stimulus is significantly greater than the differences between reactions to a weak and moderate stimulus, even though the objective difference between the two stimulus pairs is identical. Directional predominance refers to a situation where, in a bithermal test of caloric irrigation, the sum of nystagmic response to warm irrigation of the right ear and cold irrigation of the left (rightward reactions) differs substantially from the sum of responses to warm water irrigation of the left ear and cold water irrigation of the right. Directional predominance, because of its obvious relationship to asymmetry of reactions to angular acceleration, has been used as a diagnostic indicator of vestibular dysfunction. However, the diagnostic utility of this measure has not been great. The existence of the phenomenon of recruitment implies that directional predominance cannot be considered independently of the intensity of the stimuli (water temperatures) used in the bithermal test. Thus recruitment must always be considered in diagnostic vestibulometry. A new diagnostic model combining tests for recruitment and predominance is described. This model facilitates explanation of a number of empirical results heretofore inexplicable; for example, the fact that the direction of predominance does not correlate with the direction of labyrinth asymmetry. A modification of the sinusoidal test used for diagnosis of vestibular dysfunction is suggested.

P168(12/85)* Marks E, Zuzhevich V, Dvoretzki Ye, Mazhenski M (Poland). Age-related changes in the EEGs of pilots, Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 85-86. [10 references; 7 in English] Affiliation: Not available

Neurophysiology, EEG

Pilots

Aging

Abstract: Electroencephalographs have been part of aviation medical examinations of pilots and student pilots in Poland for 25 years. Consequently, it has been possible to observe changes in EEGs longitudinally over a 20 year period. The first stage of this study analyzed the EEGs of 125 pilots, average age 25.1. In the second stage, the EEGs of two groups of pilots were examined. The mean age of the first group (N=19) was 24.7 and of the second group (N=47), 43.6. [The older groups studied in Stage 2 was presumably composed of individuals whose initial EEGs were analysed in Stage 1.] From the early EEG to the later one, there was a tendency for the dominance of irregular alpha rhythms to be attenuated. There was a significant decrease in the frequency of the primary rhythm from 10.1/sec to 9.7/sec and a significant increase in the number of compound alpha waves.

MONOGRAPH

M45(12/85) Nasonkin OS, Pashkovskiy EV. Neyrofiziologiya shoka [The neurophysiology of shock]. Leningrad: Meditsina; 1984. [152 pages; 13 tables; 32 figures; 222 references; 73 in English]

Affiliation: Department of Military Surgery, S. M. Kirov Military Medical Academy

Key Words: Neurophysiology, Cerebral Hemodynamics, Metabolism; Health and Medical Treatment, Shock

Annotation: This monograph is devoted to one of the most fundamental problems related to serious mechanical injury and is based on a large number of experimental and clinical results obtained using interdisciplinary research methods. The neurophysiological mechanisms of shock are approached from a modern methodological perspective which recognizes the close integration and interrelationships between functional status, and cerebral blood supply and metabolism. The neurodynamic properties of shock are identified by means of sequential identification of changes in the EEG and generated potential of the various regions of the cerebral cortex and deep structures of the brain, reflex activity, sensory systems, higher nervous activity of animals and psychological functioning of humans. Separate chapters are devoted to analysis of disruptions of cerebral circulation, oxygen conditions and energy supply to the central nervous system. This edition is intended for physiopathologists, surgeons, specialists in resuscitation and neurophysiologists.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Introduction (5)

Chapter 1. Etiology and pathogenesis of shock (7)

Chapter 2. Electrical activity of the brain (23)

Electrical activity of the brain in experimental shock (23)

Electrical activity of the brain in human shock (52)

Recovery of electrical activity of the brain in humans

resuscitated almost dying from grave mechanical injury (62)

Conclusion (73)

Chapter 3. Reflex activity in shock (75)

Chapter 4. Sensory systems (88)

Chapter 5. Higher nervous activity (95)

Chapter 6. Cerebral circulation (106)

Chapter 7. Oxygen conditions in the brain (112)

Chapter 8. Energy supply to the brain (121)

Chapter 9. Disruption of brain activity; Mechanisms and role in shock
(126)

References (138)

NUTRITION
(SEE ALSO METABOLISM: P170)

PAPER

P174(12/85)* Popov IG. Hygienic aspects of the daily diet of flight crews. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina. 19(5): 4-19. [75 references; 7 in English] Affiliation: Not available

Nutrition, Daily Diets
Flight Crews
Review Article

Abstract: This paper reviews the recommended and provided diets for flight crews in the USSR from the 1920s to the present day. Daily caloric values of past diets tend to be about 3500- 4500, with some lower during economically distressed years and some as high as 5100 for student pilots. Over the years some attempt has been made to consider the influence of flight factors, such as hypoxia, on recommended diets. Although exact caloric and essential substance components of the current diet are not specified, it is stated that with respect to nutritional norms determined in 1982, the current diet exceeds requirements for persons engaged in very heavy physical labor. According to these norms the caloric requirements for such workers aged 18-29 is 4300 cal/day and for those aged 30-39 is 4100 cal/day. The authors conclude that the physiological and hygienic requirements for daily diets of flight crews may be determined as follows: 1) the caloric value of the daily rations must fully compensate for energy expended, while the nutrients should correspond to the body's requirements in the appropriate climatic and geographical area; 2) each of the three main meals of the day must be nutritionally balanced; 3) the meal schedule and the allocation of the food ration to different meals must be in accordance with the day's schedule and the nature of the flights; 4) daily rations must include only products specifically recommended in flight nutritional standards; 5) substitutions for recommended products must occur only in exceptional cases, associated with climatic and geographic effects on metabolism, or sanitary and culinary considerations, and must conform to nutritionally sound rules for food substitution; 6) products and prepared dishes must be selected with due regard for the effect of adverse flight factors on the body and for effects of flight on the functioning of the digestive tract; 7) the food prepared must taste good, be sufficiently varied and present no danger from the standpoint of sanitation and disease.

PERCEPTION

(SEE ALSO: MATHEMATICAL MODELING: M41)

MONOGRAPH

M35(12/85) Travnikova NP. Effektivnost' vizual'nogo poiska [Effectiveness of visual search]. Moscow: Mashinostroyeniye; 1985. [129 pages; illustrated with figures and tables; 91 references; 17 in English]

Affiliation: Not Available

Key words; Perception, Visual Search, Optical Instruments, Human Performance, Personnel Selection

Annotation: This book presents principles governing visual detection of objects, which have been derived from theoretical and experimental investigations. In addition, it cites analytic formulas for computing detection probability and latency, and search efficiency as a function of observation conditions and the characteristics of the object itself. The author gives examples of practical applications of these principles to the solution of specific problems involving visual search with or without optical instruments. This book is intended for engineers working with optical instrumentation, specialists in engineering psychology, ergonomists, and image specialists.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Chapter 1. Threshold conditions for observing objects with the naked eye (4)

- 1.1 Visibility of extended objects (5)
- 1.2 Visibility of points (15)

Chapter 2. Principles of visual search for extended objects (27)

- 2.1 Search for objects as a stochastic process (27)
- 2.2 Major factors determining visual detection of objects (30)
- 2.3 Evaluating the influence of search parameters on detection probability and latency (32)
- 2.4 Principles of visual search for extended objects (60)
- 2.5 Principles of visual search for extended moving objects (68)

Chapter 3. Principles of visual search for point light sources (75)

- 3.1 Major factors determining visual detection of point light sources (75)
- 3.2 Investigating the influence of the major parameters on detection probability and latency for points (76)
- 3.3 Principles of visual search for points (82)

Chapter 4. Predicting the detection probability of an object (86)

- 4.1 Calculating the detection probability and latency for objects as a function of the external conditions of observation (86)

4.2 Influence of the parameters of optical instruments on detection of objects (94)

4.3 Search for objects by means of scanning (101)

Chapter 5. Techniques for evaluating the effectiveness of visual search (107)

5.1 Criteria for the effectiveness of a visual search (107)

5.2 Determining the effectiveness of optical instruments in the search for various objects (108)

5.3 Determining the capability of operators to perform visual search. Devices used in selecting and training operators to perform visual search. (115)

References (125)

PERSONNEL SELECTION

(SEE ALSO: CARDIOVASCULAR AND RESPIRATORY SYSTEMS: P166;
NEUROPHYSIOLOGY: P141; PERCEPTION:M35)

PAPER

P152(12/85) Bodrov VA, Fedoruk AG. Functional asymmetry of paired organs in members of flight crews. Voenno-meditsinskiy Zhurnal. 1985(7): 50-52. [11 references; 2 in English] Affiliation: [Armed Forces] Medical Corps

Personnel Selection, Physiological
Humans, Flight Crews
Functional Asymmetry

Abstract: On the basis of some American data indicating that left-handed pilots were more likely to attrite or lose work time due to illness, the authors investigated hand, eye, ear and foot dominance in pilots and students in flight training as compared to individuals not involved with flying (numbers not specified). Standard tests of dominance, (e.g., preference for use of hand, differential hand strength, eye preference when sighting a target, and dichotic listening) were used. No significant differences in degree of right dominance were found between the subject groups in overall results on the test set. A group of pilots was divided into subclasses on the basis of job performance. The group of less competent pilots contained more individuals showing left dominance, and mixed dominance, particularly when vision, hearing and handedness were considered.

RADIOBIOLOGY

(SEE ALSO: EXOBIOLOGY: P177; BIOSPHERICS: M52, M53)

PAPERS

P149(12/85) Kyshtobayev ShK, Razumovskiy YuK, Turganbayev ZhT. Changes in oxidation-reduction (redox) and hydrolytic enzymes of rat pituitary glands in response to irradiation at low mountain elevations. Zdravokhraneniye Kirgizii. 1985(4): 20-22. [No references]
Affiliation: Department of Pathological Anatomy, Kirgiz State Medical School.

Radiobiology, Irradiation

Rats

Enzymology, Pituitary, Redox

Abstract: Twenty-four albino rats were irradiated at a dosage of 550 rad at an altitude of 770 m. Six animals were not irradiated and served as controls. Of the irradiated animals, six each were sacrificed on days 3, 14, 21, and 30 after irradiation and their pituitaries were removed. Histoenzymological investigations of lactate dehydrogenase, succinic dehydrogenase, NAD-diaphorase, cytochrome oxidase, transport ATPase, alkaline phosphatase and acid phosphatase were performed on cryogenic cross sections of pituitary tissue. On day 3 after irradiation, an increase in activity of lactate dehydrogenase, a decrease in succinic dehydrogenase and ATPase, as well as a sharp decrease in both acid and alkaline phosphatase activity were observed in the posterior pituitary lobe. All investigated activities decreased in the anterior and middle lobes. After 14 days, lobe activity of NAD-diaphorase, acid and alkaline phosphatase and ATPase increased in the posterior lobe, while all activity of all other enzymes remained at their previous level. Changes observed in this first phase are described as decreasing expenditure of energy by means of oxidative phosphorylation and anaerobic glycolysis. On days 21 after irradiation the beginning of a normalization process was observed and most indicators had returned to control level by day 30.

P183(12/85) Fedorenko BS, Karpovskiy AL, Ryzhov NI, Krasavin YeA. Study of radiation damage in the brain tissue of rats. In Dubinin NP, editor, Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 152-158. (See Issue 1 of Digest, pp. 66-69.)

Radiobiology, Brain Tissue; Neurophysiology, Histology

Rats

Space Flight, Cosmos; HZE

Abstract: The subjects of this experiment utilized eight Wistar rats exposed to space flight conditions, including HZE radiation, for 20.5 days on the "Cosmos-605" and "Cosmos-690" satellites. The five rats on the latter craft were also exposed to gamma rays in a dose of 220 rads during flight. Plastic HZE detectors were implanted beneath the skin of the rats' heads two weeks preflight. Twenty-six days postflight, the rats were sacrificed and the detectors removed and read. Brain tissue was fixed and a number of histological sections obtained, stained and examined through a light microscope. Particular attention was paid to the nature of structural changes occurring in the regions of the projected HZE tracks. Examination of detectors revealed that in 45 cases, particles with mass greater than 6 passed through the brains of the rats. The tracks of these particles through the brain were projected, and relevant tissue was studied in 32 instances. In only two cases was focal degeneration of glial cells noted along the projected particle track. In all remaining cases, no local damage was observed along the projected HZE tracks. However, damage of nerve and glial cells was noted beyond the projected track. In all rats there were also changes in individual cells not on the particle track, as well as diffuse vascular impairment in the form of swelling of arteriole walls, thickening of the interior elastic membrane and enlargement of the nuclei of muscle and endothelial cells. Such changes were also seen in the brain tissue of synchronous control animals, but these were not as pronounced. The low correspondence between local brain areas projected to be in direct contact with HZE and areas of histologic damage to brain tissue is attributed by the authors to the effects of particles with mass less than 6 and heavy particles not registered by the detectors.

In the ground-based experiments, a total of 90 Wistar rats were exposed to proton radiation in a single dose of 9 GyW/nucleon, helium ions in a dose of 4.3 GyW/nucleon or ^{60}Co gamma radiation in doses of 50, 100, 200 and 400 rads. Rats were sacrificed and brain tissue was examined 21 days or 3 months after exposure. In another study rats were irradiated with neon ions at rates of 10^4 and 10^6 part/cm², sacrificed and studied 1 to 12 weeks after exposure. Results of these treatments on the brain tissue of the subjects are presented in Tables 43 - 45.

Tables

Table 43. Damage to neurons of the external granular layer of the cortex of the large hemispheres of brains of rats 21 days after irradiation

Radiation Type	Dose, rads	Quantity of neurons, %				Irrevocably altered neurons, HD+DN
		UC	LD	HD	DN	
Protons	50	74.6	15.7	8.5	0.9	9.7*
	100	66.2	17.6	15.0	2.2	16.2*
	200	62.7	17.4	17.2	2.7	19.9
	400	54.6	18.6	20.6	1.7	26.8*
Helium ions	50	75.0	15.6	8.9	0.8	9.4*
	100	66.9	20.8	10.9	1.4	12.3
	200	63.0	17.8	17.9	1.3	19.3
	400	58.3	19.4	23.3	3.2	22.3*
Gamma rays	100	83.3	13.2	3.5	0.0	3.5
	200	80.6	14.0	5.2	0.2	5.4
	400	75.8	13.4	10.6	0.2	10.8
No irradiation		90.5	4.0	2.1	0.4	2.5

UC=unchanged; LD=light damage; HD=heavy damage; DN=destroyed neurons

* Numbers in the original either do not add up to 100%, or HD column and DN column do not add up to HD+DN column, or both.

Table 44. Damage to neurons of the external granular layer of the cortex of the large hemispheres of brains of rats 3 months after irradiation

Radiation Type	Dose, rads	Quantity of neurons, %				Irrevocably altered neurons, HD+DN
		UC	LD	HD	DN	
Protons	50	60.7	24.8	11.6	1.0	14.5*
	100	55.1	24.5	19.1	1.3	20.4
	200	51.3	23.6	22.8	2.3	25.1
	400	46.0	23.5	26.5	4.0	30.5
Helium ions	50	63.5	23.9	13.6	0.9	14.5
	100	60.3	22.8	15.6	1.3	16.9
	200	54.0	21.9	22.6	1.5	24.1
	400	49.9	20.5	27.5	2.1	29.6
Gamma rays	100	81.4	14.4	3.9	0.3	4.2
	200	78.5	15.4	5.9	0.2	6.1
	400	73.4	14.7	11.9	0.4	11.9*
No irradiation		92.9	4.8	1.9	0.4	2.3

*See note to Figure 43.

Table 45. Damage to neurons of the external granular layer of the cortex of rat brains after irradiation with neon ions

Time of observation, weeks	Quantity of neurons, %		
	UC	LD	HD+DN
1	87.7	7.2	5.1
3	83.7	11.3	5.0
5	79.1	13.7	7.2
12	74.2	16.8	9.0
Control	92.9	6.4	0.8

P184(12/85) Nevsgodina LV. Study of the effect of galactic HZE's on air-dried seeds of Lactuca sativa. In Dubinin NP, editor, Biologicheskiye issledovaniye na orbital'nykh stantsiyakh "Salyut" [Biological investigations on "Salyut" orbital stations]. Moscow: Nauka; 1984; pp. 158-162. (See Issue 1 of Digest, pp. 66-69.)

Radiobiology, Cell Aberrations, Botany; Genetics
Lettuce, Seeds
Space Flight, Salyut-6, Cosmos; HZE

Abstract: This paper describes experiments in which air-dried lettuce Lactuca sativa seeds were exposed to HZE radiation on the "Cosmos-936" satellite and "Salyut-6" orbital station. On the "Cosmos-936" seeds were housed in the cabin in a biostack containing several physical detector plates for registering HZE radiation and five seed holders. Other seeds packaged in polyethylene bags were exposed directly to space outside the "Cosmos-936" and still others were housed in the inhabited section of the "Salyut-6." Total radiation dose was measured as 0.5 ± 0.07 rad inside the satellite, 1.5 rad outside the satellite and 3.7 rad inside "Salyut-6." All seeds were germinated postflight and after 48 hours the sprouts were fixed, stained and subjected to cytogenetic analysis. Seeds housed inside the "Kosmos-936" showed more cell chromosome aberrations than control seeds; however, flight seeds which detectors showed had been hit by HZEs had no more aberrant cells than flight seeds which had not been hit. However, there was a significant difference between these two groups in number of cells with multiple aberrations (see Table 46). Closer examination showed that all seeds where an HZE had hit or come close to the root meristem had multiple aberrations. Seeds where the cotyledon or seed coat had been hit also showed a high percentage of aberrant cells, as well as changes in development. Seeds exposed directly to space outside the satellite had more aberrant cells by a factor of 1.5 to 2.00 than control seeds (see Table 47). The "Salyut-6" experiment increased the duration of exposure to space up to 175 days; under these conditions the number of aberrant cells was four times that of a control and significantly greater than for seeds with shorter exposure to space. However, although exposure to space increases the number of cells with multiple aberrations, this effect was not directly correlated with exposure duration (see Table 48).

Table and Figure Titles: Figure 57: Diagram of the position of lettuce seeds on the nitrocellulose plate

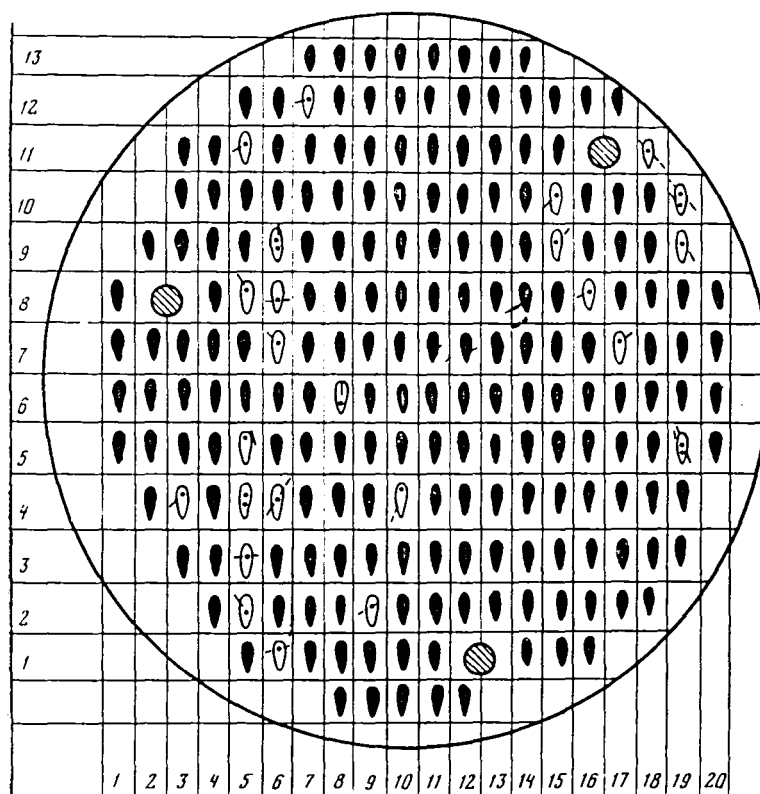


Table 46. Cytogenetic analysis of seed cells after exposure to space in an internal container on the "Cosmos-936" satellite

Condition	Number of seeds Observed	Seeds with chromosome aberrations		Seeds with multiple aberrations	
		Number	%	Number	%
Control	1307	31	2.4	0	0
Flight. Seeds not hit by HZE	2273	107	4.8	6	0.26
Flight. Seeds hit by HZE	2353	129	5.5	18	0.76

Table 47. Cytogenetic analysis of seed cells after direct exposure to space outside the "Cosmos-936" satellite

Condition	Number of seeds Observed	Seeds with chromosome aberrations		Seeds with multiple aberrations	
		Number	%	Number	%
Control	2548	85	3.3	0	0
Container 2	1920	117	6.1	7	0.36
Container 3	1254	51	4.1	3	0.24
Container 4	2466	121	4.9	6	0.21

Table 48. Aberrant cells in seed germinants as a function of duration of exposure to space

Spacecraft	Flight Duration, days	HZE Fluence ($Z < 6$, part./cm ²)	Aberrant cells, %	
			Single* Aberrations	Multiple Aberrations
"Cosmos-368"	7	Not measured	1.06	0.16
"Cosmos-782"	20	5.0	1.45	0.13
"Cosmos-936"	20	From 2.6 to 6.3	2.40	0.28
"Salyut"	72	Not measured	2.00	0.21
"Salyut-6"	175	33.6	3.52	0.28

* Corrected for spontaneous level.

MONOGRAPHS

M36(12/85) Miroshnichenko LI, Petrov VM. Dinamika radiatsionnykh usloviy v kosmose [The dynamics of radiation conditions in space]. Moscow: Energoatomizdat; 1985. [150 pages; 20 tables; 84 figures; 151 references; 78 in English]

Affiliation: Institute for Terrestrial Magnetism, the Ionosphere, and Radiowave Propagation, USSR Academy of Sciences; Institute for Biomedical Problems, USSR Ministry of Health.

Key Words: Radiobiology, Galactic and Solar Radiation

Annotation: This work summarizes and analyzes the observational and theoretical research data on galactic and solar radiation and on the radiation belts of the Earth relevant to investigation of the dynamics of cosmic radiation. Radiation sources are briefly described from a dynamic (space physics) perspective. The physical parameters which determine the distribution of particles in the sun's corona, and in interplanetary and near-Earth space are analyzed in detail and methods for predicting streams of solar radiation are described. This book is intended for scientists.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Introduction (5)

Chapter 1. Radiation conditions in space (6)

1. Basic concepts, definitions and terms (6)
2. Elements affected by radiation (7)
3. Radiation sources (9)
4. Nature of radiation effects (14)
5. Evaluation of radiation conditions (16)

Chapter 2. Physical conditions in space (20)

1. Solar activity and the heliomagnetosphere (21)
2. Properties of interplanetary space (24)
3. Motion of charged particles in interplanetary space (27)
4. Geomagnetic field (32)
5. Dynamics of radiation in the magnetosphere (36)

Chapter 3. The radiation belts of Earth (38)

1. The formation of the radiation belts of Earth and their structure (38)
2. Spatial distribution of particles (44)
3. Temporal variations (50)
4. Energy spectrum (55)
5. Model of terrestrial radiation belts and their effects (58)

Chapter 4. Dynamics of galactic radiation (64)

1. Distribution of galactic radiation on the basis of energy and charge (64)
2. Temporal variations in galactic radiation intensity (66)
3. Anomaly in the spectrum (70)
4. Model of galactic radiation spectra (72)

Chapter 5. Physical characteristics and dynamics of solar radiation (75)

1. Boundaries of the spectrum (76)
2. Nuclear and isotope composition (77)
3. Anisotropy (80)
4. Emission and propagation of particles in the corona (83)
5. Transport range as a function of energy (88)
6. Acceleration of particles in interplanetary space (89)
7. The spectrum of solar radiation on Earth and at its source (92)
8. Relationship between solar radiation and the level of solar activity (99)
9. The evolution of the spectrum and the dynamics of radiation features of solar radiation (103)

Chapter 6. Interpreting and predicting the radiation characteristics of solar radiation (109)

1. Methodological approaches and limitations (109)
2. The flow measurement method (110)
3. Statistical modeling of the radiation environment (118)
4. Electromagnetic radiation flares and prediction of solar proton event (122)
5. Predicting the dynamics of solar radiation (probability approach (129)

Conclusion (141)

References (143)

M37[(12/85) Vorob'yev YeI, Stepanov RP. Ioniziruyushchiye islucheniya i krovenosnyye sosudy [Ionizing radiation and blood vessels]. Moscow: Energoatomizdat; 1985. [296 pages; 59 figures; 200 references; 107 in English]

Affiliation: Not available

Key Words; Radiobiology; Cardiovascular and Respiratory Systems, Vascular Damage

Annotation: This book presents information on radiation-induced changes in blood vessels. It includes a critical analysis of modern ideas about the processes leading to vascular structure damage after exposure to radiation. Particular attention is devoted to repair and compensation after radiation damage to the vessels, an area which has not received sufficient coverage in the literature. This book is intended for radiobiologists and clinicians concerned with radiation therapy.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Introduction (4)

Chapter 1. Clinical aspects of radiation angiology (8)

- 1.1 Vascular effects after exposure to relatively small doses of ionizing radiation (8)
- 1.2 Vascular changes after radiation therapy and their clinical consequences (14)
 - 1.2.1 Damage to organs (15)
 - 1.2.1 General hemodynamic shifts (43)
- 1.3 Vascular effects in radiation sickness and during late effects (44)

Chapter 2. Experimental study of radiation effects on blood vessels (48)

- 2.1 Vasomotor reactions and the role of changes in circulation in radiation pathology (48)
- 2.2 Structural-metabolic basis for radiation changes in major vessels (59)
 - 2.2.1 General overview of the changes (59)
 - 2.2.2 Quantitative analysis of cellular transformations in endothelia of the aorta (73)
- 2.3 Radiation damage to capillaries (91)
 - 2.3.1 Modern ideas about the nature and regional characteristics of radiation damage to capillaries (91)
 - 2.3.2 Analysis of damage to endothelial capillaries (results of authors' experiments) (105)
 - 2.3.3. Secondary pathological effects in the capillaries (153)

- 2.4 Repair and compensation for radiation damage to the capillaries (168)
 - 2.4.1 Approaches to the study of repair potential in the capillaries of the endothelia after irradiation (168)
 - 2.4.2 Analysis of intracellular repair (183)
 - 2.4.3 Analysis of tissue repair phenomena of the endothelial lining of the capillaries (200)
- 2.5 Barrier function of the vascular endothelium after irradiation. Change in vascular permeability. (207)
 - 2.5.1 Approaches to problem solving (207)
 - 2.5.2 Structural basis of functional changes in the state of the endothelium (208)
- 2.6 Effects of ionizing radiation combined with those of other harmful agents or functional stress (233)

Chapter 3. Prevention, therapy and potential for controlling modifications of vascular changes in response to radiation (262)

- 3.1 Clinical aspects of the problem (267)
- 3.2 Experimental justification for methods of prevention and treatment (267)

Conclusion (277)

References (284)

M46(12/85) Grigorov NL. Elektronny vysokoy energii v okrestnosti zemli [High energy electrons in the environment of Earth]. Moscow: Nauka: 1985. [120 pages; 28 tables; 37 figures; 48 references; 4 in English]

Affiliation: Scientific Research Institute of Nuclear Physics, Moscow State University; P. N. Lebedev Physics Institute, USSR Academy of Sciences.

Key Words: Radiobiology, Cosmic Rays, Corpuscular Radiation, Near-earth Space

Annotation: This book is devoted to high energy electrons in near-earth space. It presents theories accounting for the formation of streams of electrons captured by the Earth's magnetic field and of the electrons' albedo. Formulas are derived for determining the intensity and energy spectra as a function of the conditions under which high energy electrons were created. A model is developed which describes a broad range of experimental data concerning particles in space and the stratosphere, and which may be used in analyzing results of research on corpuscular radiation in the environment of Earth and the other planets. This book is intended for scientists working in the area of cosmic ray physics and space research and also for graduate and upper class students specializing in these areas.

CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (5)

Chapter 1. Theory of the formation of streams of high energy electrons in near-earth space (7)

1.1 Creation of electrons in the upper atmosphere (7)

1.2 Creation of electrons in the upper layers of the stratosphere (10)

Chapter 2. Entry of particles created in the atmosphere into space (17)

2.1 Motion of particles near their creation site (17)

2.2 Longitudinal drift of particles moving between mirror points (20)

2.3 The amount of matter penetrated by a particle in the atmosphere as it enters space (22)

2.4 Motion of particles leaving the atmosphere (32)

Chapter 3. Motion of electrons in a magnetic field, taking account of energy loss (36)

3.1 Translational motion (36)

3.2 Three-dimensional problem (40)

3.3 Motion of electrons in the atmosphere (41)

Chapter 4. The effect of synchronic losses of energy and plural dissipation on the formation of streams of high energy streams (46)	
4.1 The effect of synchronic energy losses on the lifetime of high energy electrons in the environment of the Earth (46)	
4.2 The effect of plural dissipation on the lifetime of electrons captured by a geomagnetic field (56)	
4.3. The effect of plural dissipation on the escape of electrons from the atmosphere (61)	
Chapter 5. Computing energy spectra at various geomagnetic latitudes (64)	
5.1 The spectrum of generated electrons (64)	
5.2 Spectra of observed electrons (67)	
5.3 High energy electrons in the internal radiation belt of the Earth (73)	
Chapter 6. Experimental study of high energy electrons in the environment of Earth (85)	
6.1 Apparatus for recording electrons with energy of 100-1000 MeV in space (85)	
6.2 Global flow of high energy electrons (89)	
6.3 Vertical streams of electrons (92)	
6.4 High energy electrons, captured by the Earth's magnetic field (97)	
Chapter 7. "Surplus" radiation in near-earth space (101)	
7.1 Rocket research (102)	
7.2 Measurements in the stratosphere (107)	
7.3 Satellite measurements (111)	
Conclusion (115)	
References (118)	

M54(12/85) Vorob'yev YeI, Kovalov YeYe. Radiatsionnaya bezopasnost' ekipazhey letatel'nykh apparatov [Radiation safety of flight vehicle crews]. Moscow: Energoatomizdat; 1983. [152 pp.; 46 tables; 16 references; 6 in English].

Affiliation: Not available

Key Words: Radiobiology, Radiation Safety, Space Crews

Annotation: This book discusses provision of protection against radiation for crews of flight vehicles of various types (aircraft, space craft and orbital stations). It examines the extent of radiation effects on humans, both on Earth and in space. Particular attention is given to the further development of the concept of acceptable risk and the application of this concept to ensuring radiation safety in space. This approach may be generalized to other spheres of activity in which humans are exposed to ionizing radiation. The book is intended for scientists.

CONTENTS

(Numbers in parentheses refer to page numbers in original.)

Foreword (3)

Introduction (5)

Chapter 1. The extent of radiation effects on humans (7)

Principle sources of radiation hazards (7)

Natural sources of ionizing radiation (9)

Increases in natural background radiation caused by industrial activity (13)

Artificial sources of ionizing radiation (16)

Summary data on the extent of radiation effects on humans (23)

Chapter 2. Biomedical principles of radiation safety (24)

Classification of the main effects of human exposure to radiation (24)

Risk of somatic damage from human exposure to radiation (26)

Risk of stochastic [late] somatic damage from exposure of humans to radiation (28)

Radiation risk levels (30)

Recommendations of the International Committee on Radiation Protection (32)

Chapter 3. Radiation safety during aircraft flights (36)

Radiation and high-altitude flights (36)

Principle sources of radiation hazards during aircraft flights (37)

Initial statistical data on passenger flights (40)

Estimating levels of radiation exposure on various aircraft flight paths (42)

Radiation safety standards for aircraft crews and passengers (44)

Chapter 4. Radiation environment during space flight (47)	
Radiation hazards in space (47)	
Galactic radiation (48)	
The radiation belt of Earth (50)	
Solar radiation (52)	
Chapter 5. Radiation safety standards for space flights (56)	
Characteristics of radiation exposure during space flights (56)	
Model of the relationship between justifiable risk dosage and duration of space flights (59)	
Radiation safety standards for space flights (62)	
Chapter 6. Principles for setting safety standards for space flights (65)	
The concept of acceptable risk as a possible basis for setting safety standards (65)	
Classification of the sources of risk (67)	
Estimating risk to an individual from various sources of radiation hazard (69)	
Extent of risk of death on Earth (91)	
Estimating acceptable risk on Earth (96)	
Safety of space flights and the concept of acceptable risk (107)	
Major sources of danger to human life and health during space flight (108)	
The general problem of providing radiation protection during space flight (113)	
A system of criteria for radiation safety standards for manned space flights (116)	
Chapter 7. Radiation hazards during space flight (123)	
Risk of somatic damage on space flights (123)	
Risk of stochastic [late] somatic damage on space flights (126)	
Radiation risk level on space flights (130)	
Radiation risk and the weight of radiation shielding (132)	
Reliability of radiation protection based on the concept of risk (134)	
Radiation risk on orbital and lunar flights (136)	
Conclusion (142)	
References (146)	
Subject matter index (147)	

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USSR REPORT: SPACE BIOLOGY AND AEROSPACE MEDICINE
[KOSMICHESKAYA BIOLOGIYA I AVIAKOSMICHESKAYA MEDITSINA]
TRANSLATION OF ENTIRE JOURNAL

Vol.19, No. 4, July-August 1985

JPRS-USB-85-006

Abstracts of the articles in this issue appeared in Issue 3 of our Digest.

USSR REPORT: LIFE SCIENCES: BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-85-023

19 September 1985

Selected Contents:

Hemodynamics During Gravitational Overloads*

(Mathematical Modeling)

(Palets BL. et al; Journal Article Abstract; 1 page)

Study of Hypokinesia and Acceleration Effects on Human Chromosomes*

(Bobkova NN; Journal Article Abstract; 1 page)

Effects of Emotional Stress on Hemostasis System of Healthy Persons
(Sokolov YeI; Journal Article Abstract; 1 page)

Assessment of State of Chronotropic and Inotropic Heart Function at
Different Degrees of Physical Fitness
(Aksenov VV, et al.; Journal Article Abstract; 1 page)

Individual Typological Features of Autonomic Reactions During
Autogenic Training in Polar Expedition Members in Period of Wintering
in Antarctica
(Sidorov, YuA; Journal Article Abstract; 1 page)

Effects of Various Doses of Some Vitamins on Non-Specific Mechanisms
of Adaptation of Man
(Novikov VS, et al.; Journal Article Abstract; 1 page)

Individual Typological Self-Regulation of Cardio-Vascular System
(Vashchillo YeG, et al; Journal Article Abstract; 1 page)

Conditioning Potentialities of Respiratory Apparatus
(Agarkov FT; Journal Article Abstract; 1 page)

Classification of Changes in Electrocardiogram During Muscular
Exertion of Healthy Individuals
(Zav'yalov AI; Journal Article Abstract; 1 page)

Vestibular Resistance and Blood Circulation Changes in Orthostatic
Position During Hypothermia
(Sobolevskiy VI; Journal Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES: BIOLOGICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-85-024

22 October 1985

Selected Articles:

Aviation Industry Clinic for Medical Examination of Test Pilots
(Dvigantsev S; Journal Article Abstract; 1 page)

Voice Analyzer for Evaluating Pilot's Condition
(Dvigantsev S; Journal Article Abstract; 1 page)

Optimal Arteriovenous Difference of Oxygen Concentration upon Physical
Exercise
(Obraztsov IF, et al; Journal Article Abstract; 1 page)

USSR REPORT: SPACE

JPRS-USP-85-005

30 September 1985

Biological Experiments, Resources Studies on 'Salyut-7'
(Newspaper Article; 1 page)

Cosmonauts Continue Earth Resources Studies
(Newspaper Article; 1 page)

Biological Life-Support Systems for Long-Duration Space Flights
(Interview with Y.Y. Shepelev; 4 pages)

Architect Discusses Space Habitat Designs
(Zigunenko S; Newspaper Article; 3 pages)

Comments on Biological Research on 'Cosmos-1667'
(Leskov S; Newspaper Article; 1 page)

Gazenko on Results Form 'Cosmos-1667'
(Leskov S; Newspaper Article; 1 page)

Energy Exchange of Plants under Weightlessness Conditions
(Tairbekov MG, et al; Journal Article Abstract; 1 page)

Use of Remote Optical Measurements in Agriculture
(Belchanskiy GI, et al; Journal Article Abstract; 1 page)

Classification of Trees by Growth Classes on Basis of Multizonal
Photographs
(Borisov AN, et al; Journal Article Abstract; 1 page)

Problems in Study and Evaluation of Consequences of Forest Fires
Using Aerospace Photographs
(Furyayev VV; Journal Article Abstract; 1 page)

Computation of Reflection of Solar Radiation from Vegetation Cover by
Monte-Carlo Method
(Ross YuK, et al.; Journal Article Abstract; 1 page)

Reflection Indicatrices of Vegetation Canopies
(Kuusk A, et al.; Journal Article Abstract; 1 page)

Approximate Analytical Formulas for Computing Spectral Brightness
Coefficients for Agricultural Vegetation
(Nilson T, et al.; Journal Article Abstract; 1 page)

Method for Using Clusters in Evaluating Land Use Areas From Multizonal
Photographs
(Vasilyev LN, et al.; Journal Article Abstract; 1 page)

Possibilities of Using Space Survey for Studying Seasonal Changes of
Landscapes in Some Regions of USSR
(Yelagin IN; Journal Article Abstract; 1 page)

Use of Goudriaan Model for Studying Reflection Regularities in
Vegetation Soil-System in Optical Range
(Vygodskaya NN, et al.; Journal Article Abstract; 1 page)

Normalization of Response of Radiometric Instrumentation for Studying
Earth's Natural Resources
(Lopes Falkon KhA. Journal Article Abstract; 1 page)

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16. Abstract <p>This is the fourth issue of NASA's USSR Space Life Sciences Digest. Abstracts are included for 42 Soviet periodical articles in 20 areas of aerospace medicine and space biology and published in Russian during the last third of 1985. Selected articles are illustrated with figures and tables from the original. In addition, translated introductions and tables of contents for 17 Russian books on 12 topics related to NASA's life science concerns are presented. Areas covered are: adaptation, biological rhythms, biospherics, body fluids, botany, cardiovascular and respiratory systems, cytology, developmental biology, endocrinology, exobiology, habitability and environmental effects, health and medical treatment, hematology, histology, human performance, immunology, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, nutrition, perception, personnel selection, psychology, and radiobiology. Two book reviews translated from the Russian are included and lists of additional relevant titles available in English with pertinent ordering information are given.</p>					
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